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POWER

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POWER GENERATION
WATER POWER
DIESEL & GAS ENGINES
AIR CONDITIONING & HEATING
REFRIGERATION
PUMPS & COMPRESSORS
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MARCH, 1936

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CORRECT LUBRICATION is certainly "doing things" to industrial costs these days! It may be rude to point—but look: The operator was raising Cain! Besides "hogging" oil, his two compressors had to be overhauled *every month.* "Moisture in the gas," said a Lubrication Engineer, and he tried *Stanolind M Oil* for the compressors • • • • Lubricators were cut from 36 drops to 8 per minute! And the operator has stopped "letting off steam"—for it hasn't been necessary to overhaul the compressors even once in the past three years!

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CORRECT LUBRICATION

POWER

A McGraw-Hill Publication—Established 1884
PHILIP W. SWAIN, *Editor*

As MAN to MAN

A PLANT ENGINEER — good friend of *Power*—was telling how he handles men. " . . . and don't forget," he warned, "that this includes the Boss." Here, we agree, is the final test of the engineer's knowledge of human nature.

Every Chief has a Boss—whether he be factory manager, vice-president or president—and every boss is a man. Knowing how to work *with* that man is the A.B.C. of every power success story.

No executive, however broad-gaged his intentions, has a completely balanced mind. His thoughts, as do those of the chief, tend to slip into the best worn ruts and there plow ahead for better or for worse. The rut of the moment may not be the most direct route to desired plant economies, but it avails nothing to pick the executive out of his rut and try to head him straight to his goal through a snowdrift. Snow plows must pioneer the better way.

Our plant-engineer friend has tested this truth. In terms of last winter he has proved that mental roads must be cleared before thought traffic will pass. In the more timely terms of coming spring and summer, he knows from experience that ideas must be planted long before the harvest of action and must be ripened with the help of sun and moisture. The Chief, in short, has learned how to work with his superior.

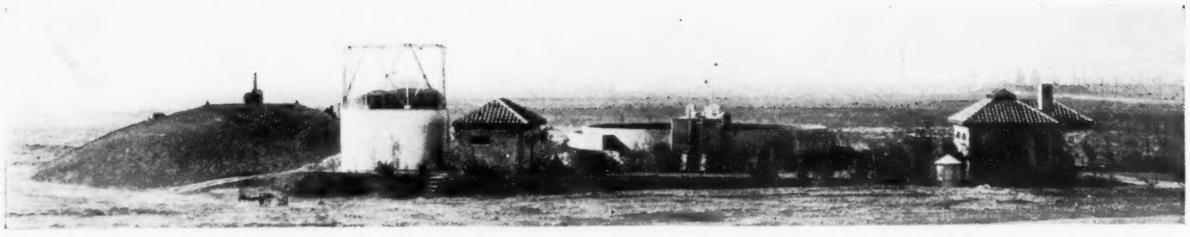
His method is explained fully on page 129; a glimpse will suffice here. The Chief keeps a typewritten running log in triplicate. As each sheet is prepared, one copy goes to the Boss. This log is a human document as well as an engineering record. It tells about the shaft that broke on Unit No. 3, but does not fail to mention the fact that Sandy Ferguson lost his store teeth when he attempted to climb a ladder with a flashlight in his mouth.

Officially, the engineering record justifies the log. The human touch makes certain that the Chief's superior will read it. The log then becomes a perfect medium for implanting ideas, for clearing mental highways to new objectives.

"Factory is using more water every day," the Chief records. "Water costs are going up. For possible future use I have been checking up on the cost of sinking a well of our own." Then he gives cost estimates, tells how deep the plant next door had to go for water, how much they found and of what analysis. No demands here, not even recommendations! Merely some facts and some "thinking out loud"—potent ideas seeded to germinate at leisure in the mind of the executive.

A few weeks later the log records further increases in water consumption and cost, hints that the day of reckoning is getting closer, adds more hard-boiled facts about wells.

Thus the idea of his own well in his own plant takes robust form in the executive mind. When the time comes for action Chief and Boss strike together and the thing is done.



A 40-hp. gas engine set supplies power for sewage treatment at Palo Alto, Calif., using digester gas for fuel

Engines Run On SLUDGE GAS

High reliability, low maintenance and self-payment within a year are outstanding characteristics of gas engines in sewage disposal

SEWAGE and sludge can be made, paradoxically, to help dispose of themselves, if the process gas generated during disposal is utilized. A number of municipalities facing the sludge disposal problem have used gas engines successfully, the three herein described being recent ones in California.

The fuel is digester gas, a product of the sludge digestive tanks, averaging about 600 to 700 B.t.u. per cu.ft. It is about $\frac{2}{3}$ methane and $\frac{1}{3}$ CO_2, with fractional percentages of other gases, including hydrogen sulphide, the latter being particularly corrosive. While digester gas appears poor beside 1,200-B.t.u. natural gas, it is considerably better than the normal 100-B.t.u. byproduct gases from blast furnaces.

Sludge gas is a comparatively slow-burning fuel due to its high CO_2 content, hence an engine burning it must have a higher compression ratio than a natural-gas engine. It also has a narrow firing range, so mixing valves must not only have the capacity to supply a lower gas-air ratio of fuel admitted to the cylinders, but must also be capable of fairly wide adjustment of incoming air to expedite starting and permit adjustment which may be necessary due to variations in gas quality. The hydrogen sulphide content of the gas affects potential compression ratio, hastens maintenance if present in very large quantities, and tends to detonate on ignition, therefore if over 0.5% is present, engine compression ratio must be decreased to avoid knock. Its formation of sulphuric acid gas and resulting corrosion of valves, cylinders, pistons and exhaust piping can be lessened by judicious use of corrosion-resisting alloys.

The high sulphur content has little effect on lubrication until the acid concentration in the crankcase becomes very high. Lubrication ills, often attributed to sulphur in fuels, are probably due rather to a combination of poor lubricating oil and dirty fuel. Two remedies avoid difficulty—more frequent draining of the crankcase, and no cooling of the exhaust near the engine, thus avoiding acid condensation in the manifold.

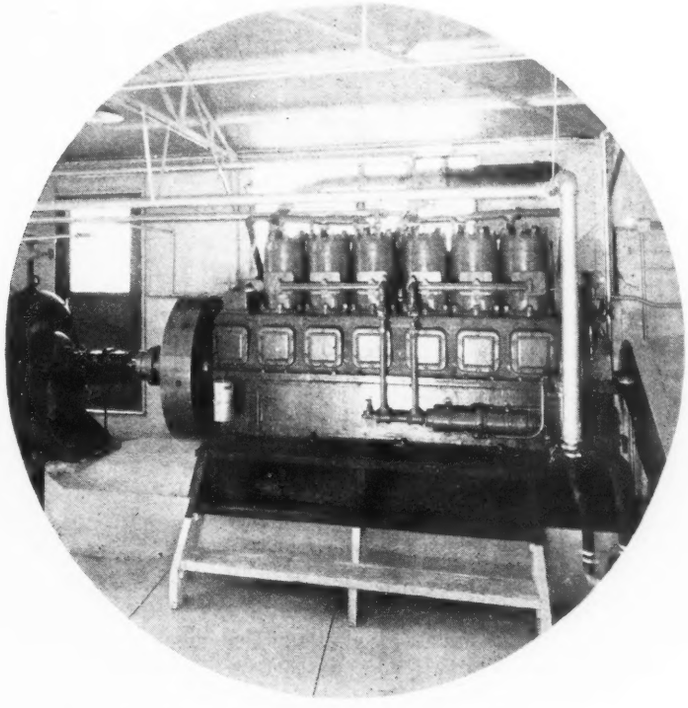
Palo Alto has a 40-hp., 4-cyl., 4-cycle, $5\frac{1}{2}$x$6\frac{1}{2}$-in., 600-r.p.m. engine driving a 30-kva., 220-volt, 3-phase, 60-cycle, 1,200-r.p.m. generator. Originally designed for operation on gasoline, the engine was increased in compression ratio by taking a light cut off the head. Placed in service Aug. 5, 1935, the unit has generated about 30,000 kw.-hr. for lifting sewage 18 ft. into the sedimentation tank. Total power required for lifting sewage and for lights and other power runs about 6,600 kw.-hr. per month, costing formerly $140. The generator set is expected to supply almost all of this power in future, utility power being used only for standby. The sewage-treatment plant is of the plain sedimentation type with separate sludge digestion, effluent being discharged into San Francisco Bay. About 30,000 cu.ft. of 589-B.t.u. gas is produced in the digester per day. It flows to a 3,000-cu.ft. gas holder and then to the engine, without cleaning or purification of any kind. Waste heat from the engine jacket is recovered by circulating it through the digester, raising sludge temperature from 68 to 100 deg. F.

After two months' operation, the exhaust valves warped due to excessive heat. They were replaced with Nichrome valves, which thus far have functioned satisfactorily. Spark plugs burn out in about 60 days. Otherwise the engine seems to be in excellent shape, and pistons show practically no wear or pitting.

Los Angeles County Plant

Los Angeles County Sanitation District installed a 200-hp. gas engine in May, 1935, to supply power for pumping effluent through 5 mi. of 36-in. concrete pipeline at 50-25 lb. pressure. The engine is a conventional vertical, 6-cyl., 4-cycle, L-head, 9x11-in. unit with aluminum pistons having five compression rings, two oil rings and a wiper ring. Compression ratio is 5.85 to 1, giving a compression pressure of 135 lb. per sq.in. The ignition system consists of a single-unit high-tension magneto and airplane self-cleaning spark plugs in the center of the head. Operating speeds range from 370 to 550 r.p.m., developing 70 to 200 hp. Total daily power output is about 3,800 hp.-hr.

The engine is started by 185-lb. compressed air from an electrically driven compressor. Enough starting air is provided to rotate the engine until the operator can find the firing range of the gas available at time of starting. Gas-air ratio is adjusted by varying air supply through a butterfly choke valve on the air intake. The engine drives a 22x18-in. horizontal centrifugal pump direct. At 550 r.p.m., the pump delivers 6,300 g.p.m. Here the variable-speed feature of the engine permits varying pumping rate to correspond with fluctuating sewage flow, loading the plant more economically and avoiding former difficulties with constant-speed motors.



Los Angeles has a 200-hp. engine running on sludge gas that will pay for itself within a year in savings

Multi-stage digesters supply 650-B.t.u. gas through an 8-in. pipeline 600 ft. long. Line pressure of ½ lb. is cut to ¼ lb. at the engine. Minimum pipeline grade is ¼ in. per 100 ft., and a sump at the engine takes out condensed moisture. No scrubber or other cleaner is provided.

The digester provides about 250,000 cu.ft. of gas a day. Under full load, engine economy is 24 cu.ft. per hp.-hr., at lower speeds it is 33. Engine efficiency is about 20%, the rest of the heat being wasted. Total potential power available from the 250,000 cu.ft. of sludge gas provided by the digester per day would be 400 hp. at continuous full load. However, some of the gas is used to heat digester circulating water and in an incinerator to burn sewage skimmings and bar screenings. As digester gas output falls off, it is occasionally necessary to shut down the incinerator. If power possibilities of the digester were fully utilized, some additional investment would be required for a peak-period gas holder, or an auxiliary fuel for low-gas-production periods.

Maintenance on this engine has been low thus far. After 375 hr. continuous service, there was no corrosion of valves or carbon deposits on cylinder heads or pistons. The combustion chamber was exceptionally clean. Tappet clearance is checked about once a week, and held at 0.005 in. with valves at full heat (engine parts are very accessible—an important point—so setting can be done at full speed). Analysis of crankcase drainings indicates that oil change is necessary only once in 2,000 operating hours or three months. Oil consumption is about 1 gal. per 5,450 hp.-hr. of the high-grade S.A.E. 30 motor oil now being used in the engines.

Most recent municipal sludge-gas engine installation is that at Ontario, Calif., where a 4-cyl., 6½x8½-in., 600-r.p.m. engine has just replaced an electric motor for driving a blower in the agitation system. Engine guarantee provides speed variation less than 4% above or below normal for any governor setting between 300 and 600 r.p.m., with 600-B.t.u. fuel. First tests showed the blower delivering 1,460 cu.ft. of free air at 4.6 lb. pressure with inlet temperature 85 deg., outlet 158 deg., and engine gas consumption of about 890 cu.ft. per hr. Calculations showed about 30 hp. were produced, indicating 30 cu.ft. of gas per brake hp.-hr., while comparison with a natural-gas engine indicated that it should be around 22. This showed that the gas first produced was diluted to about 400 B.t.u., which will be corrected in future operation.

Ontario used W. B. Walraven's formula (*Sewage Works Journal*, July, 1932) to estimate the equivalent cash value of sludge gas as compared to electric power. Slightly modified, this formula states: To find the value of sludge gas for power purposes, multiply the daily flow of sewage gas in cu.ft. by 17 times the price of electricity in dollars per kw.-hr. With a 7,000-cu.ft. per day gas flow, and an electric rate of $0.01 per kw.-hr., the annual value of the sludge gas at this plant would be $1190. This does not consider capital charges and depreciation. First cost for a motor would be $28 per hp., so allowing 12% for interest and depreciation, about $150 should be subtracted from the annual value of the sludge gas, leaving it $1040. Capitalized on a 20-yr. basis, this would permit an investment of $5,200 for the gas engine, while the actual investment was only $1,865, offering reasonable assurance that the gas engine would be more economical.

Cost figures at Los Angeles confirm gas engine economy. There the engine cost $7,000; an equivalent motor would have cost $2,700—$4,300 less. The engine distributor contracted to maintain the engine, except for spark plug and magneto replacements, for five years at 0.03 cents per hp.-hr. developed. Operating costs, including spark plugs and magneto replacements, are 0.0733 cents per hp.-hr., and lubricating oil costs 0.01

Sludge-Gas Engine Installations

	No. Units	Horse-power	Year Installed	Driving
Birmingham, England	1	150	1927	Gen.
	1	400	1928	"
	1	400	1930	"
	1	540	1934	"
	2	120	1934	"
Wassmannsdorf, Berlin, Germany	1	750	Between	Gen.
Stahnsdorf, Berlin, Germany	2	500	1927 and	"
	1	750	1932	"
Charlotte, N. C.	1	225	1928	Blower
	1	75	1928	Pump
Rockville Centre, N. Y.	1	30†	1930	Blower
	1	40†	1930	Gen.
San Bernardino, Calif.	1	40	1930	Gen.
Springfield, Ill.	1	180	1932	Blower
	1	157	1934	"
Los Angeles Co., Calif.	1	200	1935	Pump
	1	200	1934	"
Cedar Rapids, Iowa	1	230	1935	Gen.
Palo Alto, Calif.	1	40	1935	"
Ontario, Calif.	1	40	1935	Blower
Madison, Wis.	1	230	1935	Blower
Ann Arbor, Mich.	1	120	1935	"
Peoria, Ill.	1	550	1935	Blower
	1	300	1935	Gen.
Coney Island, N. Y.	3	300	Proposed	Gen.
District of Columbia	1	750	Purchased	Gen.
Durham, N. C.	2	150	1935	Gen.

cents per hp.-hr., so total operating and maintenance cost (except fuel) is 0.1133 cents per hp.-hr. Assume 15% for interest and depreciation on investment.

Electric power would cost 0.53 cents per hp.-hr. Assuming this power rate and the plant's present load factor, and 10% interest and depreciation, over-all costs for engine or motor would be identical for the period May 4, 1935 to April 1, 1936. In other words, the engine will have paid its additional first cost within a year after installation.

Calculated another way, the engine is now showing a saving in operating costs of almost $500 per month, which will increase as load factor increases. Extending these figures to the average daily output of gas from digester tanks, the gas at the joint disposal plant has a value of about $1,200 per month, or 16 cents per 1,000 cu.ft. of gas developed as applied in engine fuel.

Operation of these three plants would indicate high reliability, coupled with low maintenance and practical elimination of fuel cost, size of plant being limited only by available gas supply. Engines may be direct-connected to centrifugal pumps, air compressors, or generators.

In generator drives, the engine runs at constant speed considerably below full load most of the time. This simplifies installation, but gives poor fuel economy at partial load due to low m.e.p. In driving a centrifugal pump, there is likely to be less variation in load, so the installation can operate at near full load and constant speed, a relatively simple installation. In direct-driving air compressors, possible advantages of fuel economy through speed variation are counterbalanced by difficulties with critical speeds, unless the engine designer is very careful.

Reliability should be about 95 to 98%. Maintenance costs should be low—engineers recommend $2 per b.hp. per year as a basis for estimating. Engineers figure average fuel consumption at about 20 cu.ft. of sludge per hp.-hr., varying of course with gas quality. Corrections should be based on 10,000 B.t.u. per hp.-hr. in a well-designed engine. Fuel costs are normally only the charges against the investment in storage facilities and piping. Under these conditions, many installations pay for themselves in about a year.

Durham, N. C., has two sludge-gas engines to power its sewage-disposal plant. They are 4-cyl., 150-hp., 360-r.p.m. converted diesel engines driving 100-kw. alternators with direct-connected exciters. Gas has a heating value of about 760 B.t.u. per cu.ft. Waste heat recovered from the engine maintains sewage temperature of 82 deg. in the digester.

Palo Alto's gas-engine set was originally a gasoline engine. It provides 6,600 kw.-hr. per month at no fuel cost except interest on investment in piping and gas holder

Burlington's Turbine

PUBLIC Service Electric & Gas Co. started commercial operation of its superposed plant at Burlington, N. J., (*Power*, March and April, 1933), late in November, 1933. The plant consists of a new high-pressure boiler and an 18,000-kw., non-condensing turbine with inlet conditions of 650 lb. per sq.in., and 825 deg., and exhausting at a maximum pressure of 190 lb. per sq.in., into three old 12,500-kw. low-pressure turbines. The combination forms a 55,500-kw., 4-cyl., cross-compound unit operating under thoroughly modern steam conditions. The old boilers are kept as standby. One, two, or three low-pressure turbines can be used in conjunction with the high, or high-pressure steam can be bypassed around the new turbine, desuperheated, and admitted into low-pressure units. Consequently, the high-pressure boiler or any turbine can be taken out of service and still leave two-thirds to three-quarters of plant capacity.

When the turbine was opened in August, 1934, the steam path was in excellent condition, requiring only replacement of one dummy seal strip and a few seals in the outer glands. Minor changes were made to the governing system, and the blading was cleaned.

The turbine was again opened late in March, 1935, for blade cleaning and inspection in preparation for the long-delayed acceptance tests. (The original acceptance tests of October, 1933, were inconclusive because of the large amount of scale deposited in the blading before and during the tests).

Blading was in excellent condition, and sealing strips so lightly and uniformly worn that an axial displacement of the rotor of only 0.004 in., was necessary to restore original clearances. Test showed an internal efficiency record of over 91%, corresponding to an over-all rankine cycle efficiency ratio at the generator terminals of over 86.5%. With these efficiencies it is hard to conceive of any very extensive deterioration during 16 mo. of operation.

Westinghouse Elec. & Mfg. Co. N. D. GOVE.
Turbine Engineer

THIS IS NO BULL!

By N. L. Rea

Construction Engrg. Dept.,
General Electric Co.

In the Andes, power is a thing to be welcomed with songs and dancing — and bull fights

A CITY high in the Andes decided, some years past, that it wanted and needed electric light and power, so it ordered a complete plant from General Electric. It also requisitioned an erector to install the equipment. Knowing this might not be as simple as it appeared, we selected an all-around man with unlimited tact and horse sense who knew his Spanish.

In the Caribbean, our man went through the "eye" of a hurricane. It blew great guns for hours with heavy seas, then turned into a choppy, turbulent sea with no wind—a few hours of this, then a roaring gale in the opposite direction. Everyone was locked in his cabin for several days, with occasional surges of water up and down the passageways. Our man had an outside room, forward under the bridge. They locked him in all right but, early in the blow, a roaring sea burst in his cabin door. There was a stretch of open deck to be crossed to the main cabin entrance. Hanging on inside his cabin entrance, he counted the seas to catch the gap in the series. Then, as the last giant went roaring by, he dashed across the open deck and made the entrance just ahead of the next green water.

Three days later they limped into Colon minus one funnel and most of the boats and loose gear. A sorry sight, but mighty thankful to be alive.

Then across Panama by rail and a long, slow trip down the West Coast in a boat that made all local stops. Next, a rail trip back to the high country where it was always early June and the natives grew three crops a year. Strawberries every day if one wanted them that often.

. . . from volcanoes

The first job was getting acquainted. "Speak a little English, please; no one here has ever heard any" was an oft-repeated request. Then to work on the job. No definite plans made but nature had been good to them. Some thirteen kilometers of canal to lay out and dig to bring the water from the snows on the high peaks to the edge of the mesa in the town. Here head gates were built and the water dropped over the edge to the power house in a little park. The power house was built of pumice obtained from nearby volcanoes. When first quarried it could be easily shaped with a hand saw or machette, but it soon hardened.

The bulk of the labor was Indian, the women working with the men, and more dependable and harder workers.

Of course the erecting engineer had, of necessity to be a master of all trades and run a school for the training of workers for all but the simplest tasks. "You will be a rigger, you a machinist, and you an electrician; and I will show you how you do your jobs." At times extra help was needed to move a heavy piece, or something of the kind. The power house was right in town so the Engineer would step out on the street and grab hats as the citizens walked by. (Such hats! Panamas such as we never see; fine enough to look like cut velvet at a little distance). "You are a citizen, this is your plant, we need your help a few minutes and you'll get your hat back when the job is done." This was a great joke and the successive victims joined in by keeping out of sight 'til enough hats were collected to do the job in hand.

. . . labor by hat

In due time the plant was finished, the street lights were installed, and the plant was ready for service. Now for a real celebration! A week's fiesta, with a bull fight every day. An open space in the park with double rows of trees bordering the walks on either side was fenced, with frequent openings for a man, yet "bullproof and strong." Timbers were lashed to the trees, and boxes made. When all was in readiness the show started. The youth, beauty and elite gathered in the boxes, the band played, and the fun commenced.

A half-wild bull, equipped with large leather pads like boxing gloves firmly fastened on his horns, was turned into the arena. Then some young man displayed his agility, grace and skill by taking his serape and playing tag with the bull. If the bull was too good, one found the holes in the fence, and on occasions the bull assisted one in getting through or over.

When the bull tired they put in a fresh one, and there was no end of volunteers among the young men. Everybody had a good time, including the bull, and no one was hurt. Of course the erecting engineer came in for his share of glory. Nice things were said to him and of him. He received the official thanks of the municipality and a suitable remembrance. Then farewell to the many friends made, and the long trip back to a work-a-day world where everyone is always and forever in a hurry.

. . . assisted by the bull

SPEED TO ORDER ON MOTORED

Electrical controls on variable-speed motor-driven fans provide speeds for ventilation, industrial-process and combustion requirements. Here are types and arrangements

SPEED control is frequently essential for efficient operation of fans. How this speed adjustment is obtained depends upon a number of factors. Basically, either a constant-speed motor with variable-speed transmission or a variable-speed motor may be used. This article considers only the latter.

Variable-speed motors may be grouped in six classes:

1. D.C. shunt motors with adjustable resistance in the shunt field, Diagram A.

2. Multi-speed induction motors with their stator windings arranged so they may be grouped to give two or more fixed speeds, Diagram B.

3. Wound-rotor induction motors with external resistance arranged to give several fixed speeds, Diagram C.

4. Commutator-type, polyphase, a.c. motors with speed controlled by changing position of brushes.

5. Variable-voltage control, each fan supplied from its own motor-generator, and fan motor speed controlled by adjusting generator field current, Diagram D.

6. Reduced primary voltage method (limited to small fans), Diagram E.

The shunt motor is simplest for obtaining adjustable speed where direct current is available. If the speed range is not more than 3 to 1 it can be obtained by shunt-field control. Armature control will give additional speed reduction, as power required at a low speed is small and resistance loss is not large. Field current on this type of motor is usually not more than 5% of its full-load rating, therefore can be handled by simple switching, even in large motors.

Where automatic control of fan speed is required, a motor-operated field rheostat can be used. Although this is the simplest form of adjustable-speed drive for fans, direct current is seldom available, so special arrangements would have to be made to supply it. Small fans can often be operated from an auxiliary d.c. source provided for other purposes.

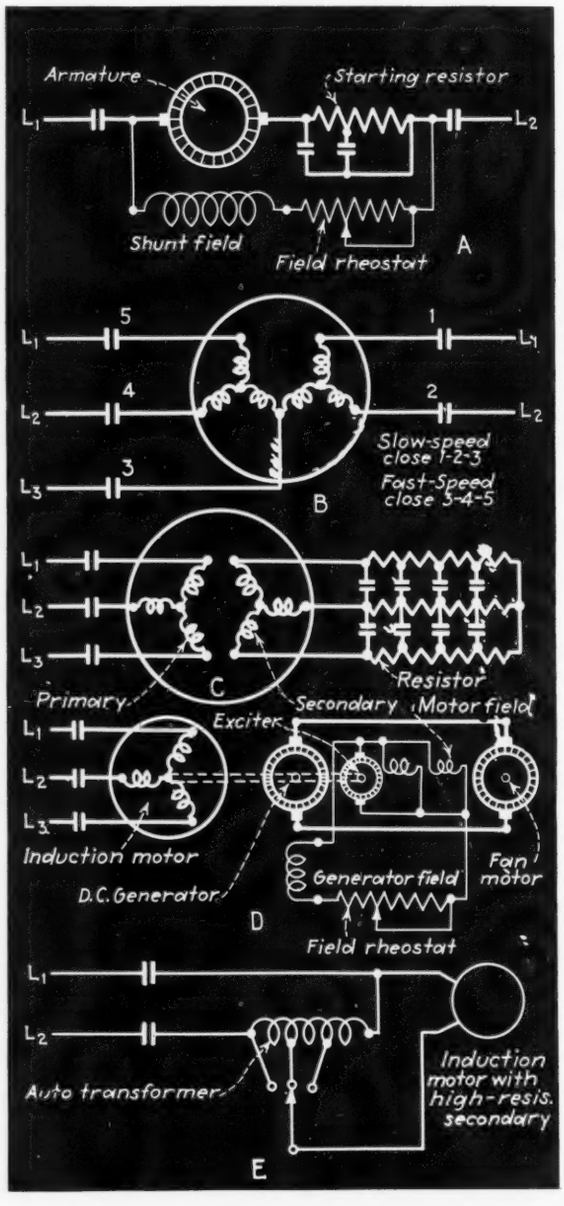
Multi-speed induction motors have primary windings arranged to give more than one combination of poles. Separate windings may be used for each speed, or the coils in a single winding may be regrouped to give a 2 to 1 pole combination. Four-speed motors use both arrangements. The secondary may be squirrel cage or connected to slip rings for rheostatic control. Multi-speed motors have the disadvantage that speed is limited to two or four fixed values, and at the lower speeds their efficiency and power factor are low.

Alternating-current is the power source in most localities, and for that reason wound-rotor induction motors have been used for many fan applications. The speed of this motor is reduced by inserting resistance in the rotor circuit, and its efficiency decreases directly with speed. Since the power required by a fan decreases as the third or fourth power of its speed, horsepower input at half speed is small compared to full speed. Consequently losses at low speed may not be serious.

This type of motor is limited to a speed reduction of about 50%. Below that value, motor operation is likely to be unstable. Operating speeds are limited to the number of points in the control, which on automatic control must be kept to a small number. Where a wide range speed is required, it may be desirable to use a multi-speed wound-rotor motor having two or more fixed speeds (obtained by changing the number of poles in the stator. Speed ranges below the fixed points are then covered by rotor-resistance control.

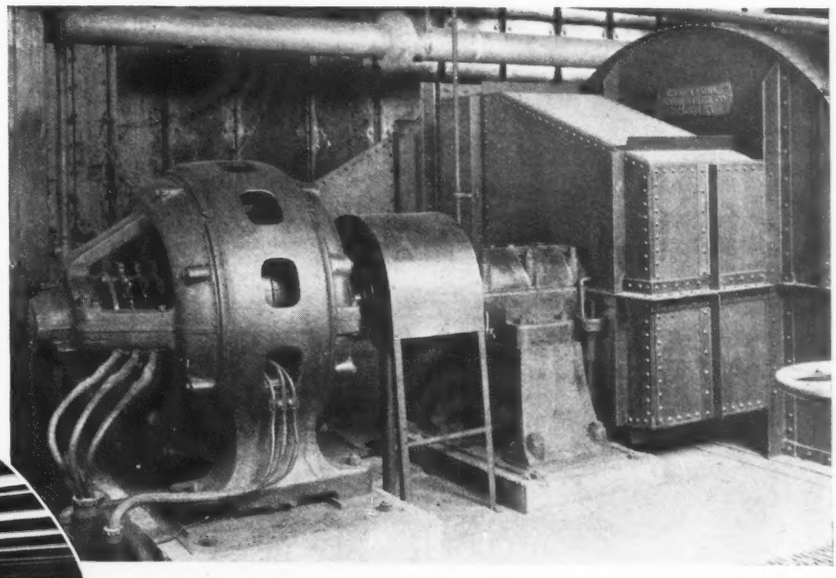
METHODS OF CONTROLLING MOTOR SPEED

A—Direct-current shunt motor with field control. B—Induction motor with primary winding for different numbers of poles. C—Wound-rotor induction motor with rheostat in rotor circuit. D—Variable-voltage or motor-generator control. E—Reduced primary voltage for small fans

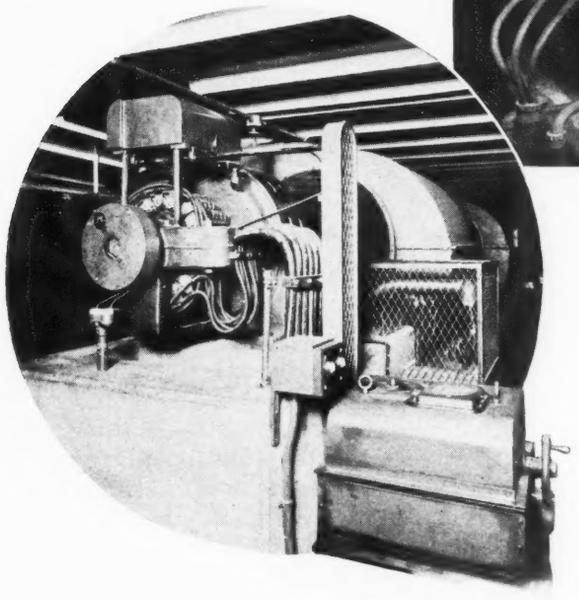


FANS

By H. D. James
Consulting Engineer



Right—Wound-rotor motor for speed control connected to induced-draft fan by magnetic clutch for disconnection when driving is done by the motor at the opposite end of the fan shaft



Below — Automatic speed-control equipment and polyphase, commutator-type, 135-hp. motor for driving a forced-draft fan

Brush-shifting, polyphase, series-type, a.c. motors use a commutator with a group of brushes for each phase and pole. That is, a 3-phase, 6-pole motor will have 18 groups of brushes on the commutator. These motors are more complicated than other a.c. types, and have a higher initial cost. For fans they provide a drive that will give a speed range of from about 12% above to 40% below synchronous speed, in an infinite number of steps, by adjusting brush position. Because of its complications and commutator with a great many brushes, its use on fan drives has been limited mostly to where a wide range of speed and close speed control is required.

Variable-voltage or motor-generator control seems to have considerable undeveloped possibilities. Ordinary considerations make it look impractical to use a separate motor-generator set for each fan motor, and the smaller the motor the greater the difficulties seem to be. However, designs have been worked up where a combination of this kind was no more expensive than a multi-speed wound-secondary induction motor with its control, and the operating characteristics were very much better.

Larger size fans can have their housing designed for mounting the motor-generator set and also the fan motor as an integral part of the housing. This design works out particularly well where the fan motor is geared to the fan through a speed reducer. Omitting the frame and mounting for an ordinary motor and motor-generator set avoids some finished surfaces and makes a very pleasing, compact design. Control of the fan using a motor-generator set becomes very simple, as its speed is a direct function of generator voltage, which, in turn, is controlled by a rheostat in its field circuit.

This control method has been extensively applied to elevators, steel mills, hoists, and is gradually being introduced in other applications. Where noise is not a controlling factor, a high-speed motor-generator set can be used, materially reducing the size and the first cost.

For small fans, usually driven by single-phase motors, reduced primary-voltage control has been used for speed regulation. The torque of an induction motor decreases as the square of the voltage, consequently, such motors become unstable if the voltage is materially reduced at their terminals. However, if the secondary resistance of a squirrel-cage motor is high, considerable speed reduction can be obtained in this way, but the energy lost in the secondary is proportional to the speed reduction and load.

Before deciding that a variable-output fan is necessary, a careful analysis should be made of the application to see if some other solution cannot be used. Ingenuity and skill may disclose other methods of solving the problem, which will reduce the initial cost and possibly the operating cost. It may be found that the fan will be satisfactory if operated at several fixed speeds that can be predetermined before installation. This requirement can be met by a geared speed reducer having two, three, or four different ratios similar to the speed changer of an automobile. These devices are available in many sizes that gives the necessary speed change by shifting a lever when the fan is at rest.

Another solution might be to bypass part of the air. It may cost less to waste some of the air than to control the total volume. In other cases some change in the process requirements might make adjustable-volume control unnecessary. No general rule can be given, as the solution will depend upon the particular application under consideration. It is, however, desirable to give careful consideration to means for using a constant-delivery fan rather than to install an adjustable-delivery unit with its added complication and expense.

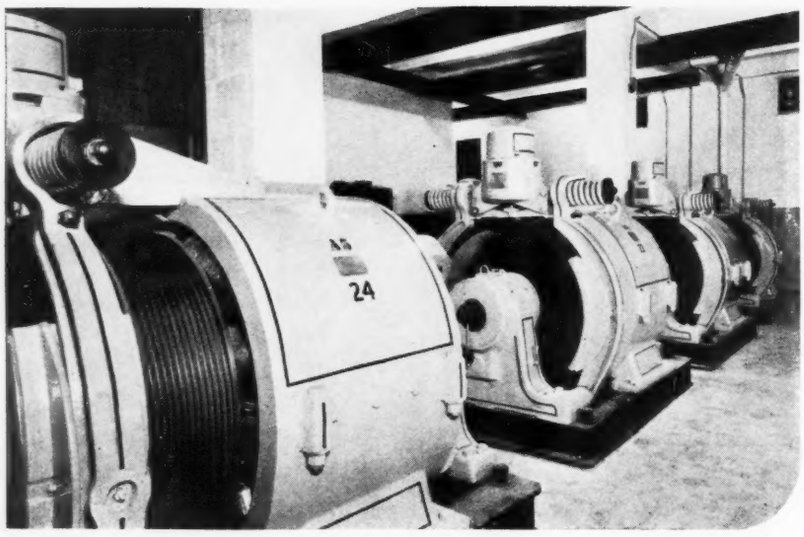


Fig. 1—Bank of high-speed elevator machines, each operated by a 125-hp., 110-r.p.m. motor

Elevators for the new International Building in Rockefeller Center have several features, including quota-system control that automatically speeds up car dispatching if demand exceeds normal scheduled operation. High-rise cars operate at 1,200 f.p.m.

ELEVATORS WITH ELECTRICAL

ROCKEFELLER Center, internationally known, is one of the largest office-building and entertainment developments in the world. At present it comprises 9 buildings varying in height from 6 to 70 stories with a total floor area of nearly 4 million sq.ft. Included are two motion picture theaters, one the largest in the world; the world's most extensive broadcasting studios; observation roofs, skytop restaurants, extensive exhibition quarters, a vast shopping center and many other activities that make this development alive with human activity for practically 24 hr. per day.

In such a vast project with a permanent population of 25,000 tenants and 75,000 transients daily, vertical transportation is of paramount importance. To provide this service in the present buildings 155 elevators and 10 escalators are installed. Two cars operate at 1,400 ft. per min. and 30 at 1,200 ft. All these cars can be operated at 1,400 ft. per min. when traffic justifies it. Some were run at 1,500 ft. per min. during performance tests, the fastest speed at which passenger elevators have operated. There are also 22 elevators that operate at 1,000 ft. per min. The others run at 800 ft. per min. or less.

Under present conditions, with some of the buildings partly tenanted, these elevators operate nearly 70,000 mi. per mo. and make approximately 100,000 stops per day. Some of the high-rise cars in the main building that do both day and night duty, run 2,700 mi. per mo., 90 mi. per day. To operate the cars requires 200 operators and dispatchers. All cars are equipped with watt-hour meters, mileage recorders and stop counters and complete records of their performance are maintained.

The International Building, a 41-story structure, the latest addition to the development, is provided with 42 Westinghouse elevators and 4 Otis escalators. This building covers the block front on 5th Ave. between 51st and 50th Sts., an area 190 x 250 ft. Its elevators, with their principal data, are listed in the table. These are similar to the 75 installed in the main building, but have a new automatic signaling and dispatching system.

Cars are scheduled by an automatic system. In each car are four lights; two, one yellow and one green under a single white glass for up direction: and two, one yellow and one red under a single white glass for down direction. These lights signal yellow, next, up; green, start up; yellow, next down; and red, start down. The next-up light flashes a scheduled interval before the start-up light. That is, if the cars run on a 30-sec. schedule interval, then the yellow next-up light flashes 30 sec. before the green start-up light. The former warns the operator no matter where the car is, that he is the next to start up. Normally the same sequence applies to the down dispatching signals.

The automatic dispatching system connects with the terminal hall signals. When a car gets a next-start signal the terminal hall light flashes for that car, even if it is not at the landing. Passengers coming to the terminal landing can see which is the next car to leave and can go to its entrance, even if it has not arrived.

The hall signals are an instantaneous type. When a passenger presses a hall button, the floor signal for the car that will answer the call flashes immediately and a low-toned single-stroke bell sounds. The passengers can then go to the car entrance and be ready to board as soon as the doors open. Those who are familiar with the confusion existing in most large elevator corridors will appreciate the great advantage of this system, which gives waiting passengers the information they need to use the elevator service intelligently.

When answering the signals of the hall passengers the cars operate on an automatic quota system. Assume that the quota of calls to be answered by any one car in one direction is three. Further assume that the cars operate express 1 to 28 floors and local 28 to 39. If, before

leaving the top floor, No. 1 car receives hall signals only to stop at floors 38, 33 and 35 it will stop at these floors and make its car-button calls and no others. No. 1 car hall lantern on floors 38, 33 and 35 will light immediately their buttons are pressed, to show the waiting passengers that this car will stop for them.

If before No. 1 car arrives at the 35th floor hall the 34th floor hall button was pressed, car No. 1 would not get this signal. Already having its quota of calls the floor-call zone has been automatically transferred to the next car down, say No. 2. On the 34th floor No. 2 car down lantern will light even if No. 2 car had not yet started down. When No. 2 gets its quota of calls, the floor-call zone is transferred to the next following car.

From the foregoing it is obvious that this system operates to give all floors elevator service in proportion to the calls registered; answers the hall calls in quotas in the sequence they are made; keeps the cars equally

BRAINS

spaced in the hoistways, except when the service demands are abnormal, at which time the schedule is automatically speeded up. Quota may be changed at will by throwing switches on the dispatcher's panel at the ground-floor landing.

The eight local cars, running from the basement to the 7th floor, have car switch, automatic-inductor landing control with solid car doors. The car and hatch doors close automatically from the car switch when starting the car and open automatically as the car lands at the floor. In addition to the elevator control, a stop-position-indicator signal system is used to enable the operator to stop at floor landings he cannot see.

The elevator machines and their control for the high-speed cars are similar to those installed in the main building. The high-rise cars run 1,200 f.p.m., their machines having sufficient capacity to operate them at 1,500 f.p.m. This duty requires a 125-hp., 110-r.p.m., elevator machine and motor that weighs 23,500 lb., and each elevator represents approximately 25,000 lb. suspended load. Variable-voltage, full-automatic, inductor-type control is used, arranged to land the car accurately at the floors.

In the car, the operator's panel is comparatively simple, as shown in Fig. 2. At the top of the panel are the dispatching signal lights, previously described. Below these lights are the car-stop buttons, which are magnetically locked in and have an individual release below each button. To the right and left of these buttons are the floor-call annunciators.

Below the floor buttons are quota-bypass buttons and their indicating lights. During rush periods, occasions may arise when a car is loaded before its quota calls are answered. The operator by pressing a bypass button can automatically transfer the unanswered calls to the nearest following car with its quota unfilled. When the transfer takes place, the floor signals are changed to indicate to the waiting passenger the car that will stop for him. Quotas are arranged, however, so that it is seldom necessary to transfer calls.

On the left, just below the quota transfer buttons and lights, is the next-floor-stop button. If it is necessary to stop the car anywhere in the hoistway, pressing the next stop button, will cause the car to slow down and make a normal stop at the next floor where such a stop can be made. The emergency-stop button on the right of the

Fig. 2 — Operator's panel in express car

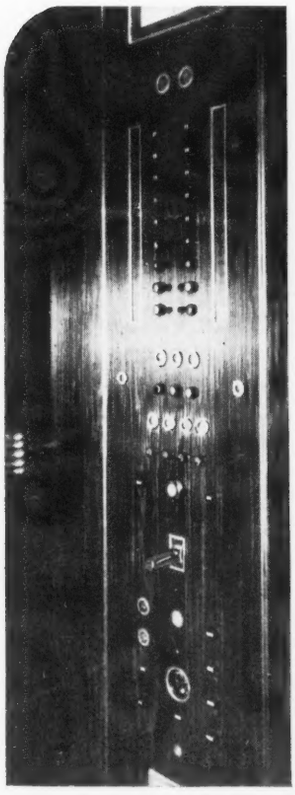


Fig. 3—One of the dispatcher's panels on which are mounted car-position indicators, floor-call annunciators, dispatching lights and quota bypass lamps

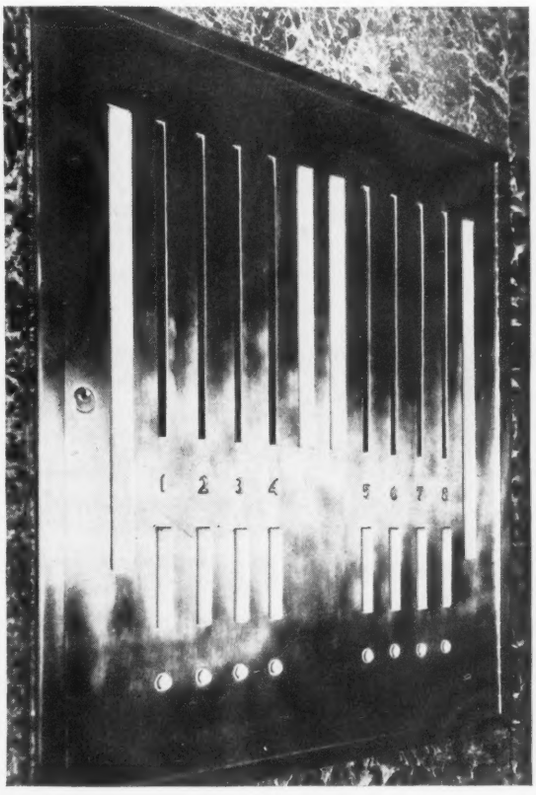
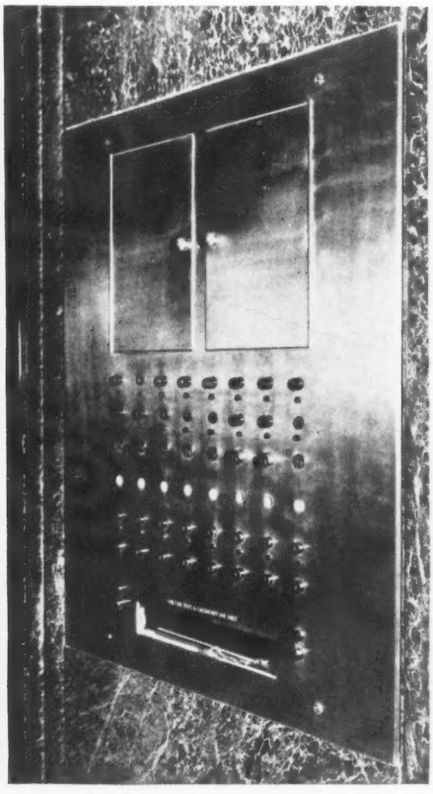


Fig. 4—Other half of dispatcher's panel, mounted on opposite wall of street-floor elevator corridor



Principal Data on Elevators in International Building

No. of Cars	Floors Rise	Express	Local	Duty	Capacity Pounds	Speed F.P.M.
17 to 24	1 to 39	1 to 27	27 to 39	Pass.	3,500	1,200
9 to 16	1 to 28	1 to 12	12 to 28	Pass.	3,500	1,000
1 to 8	1 to 14		1 to 14	Pass.	3,500	800
33 to 36	[1]B. to 7	.....	B. to 7	Pass.	3,000	600
29 to 32	[1]B. to 7	.....	B. to 7	Pass.	3,000	600
25, 27, 28	[1]SB. to 39	.....	SB. to 39	Service	3,500	700
26	[1]SB. to 39	.....	SB. to 39	Service[2]	4,500	700
37 to 38	SB. to B	.....	SB. to B.	Frt.	6,000	100
39	1 and 2	.....	1 and 2	Pass.	1,500	100
40 to 41	1 and 2	.....	1 and 2	Pass.	1,300	100
42	1 and 3	.....	1 and 3	Pass.	1,500	100

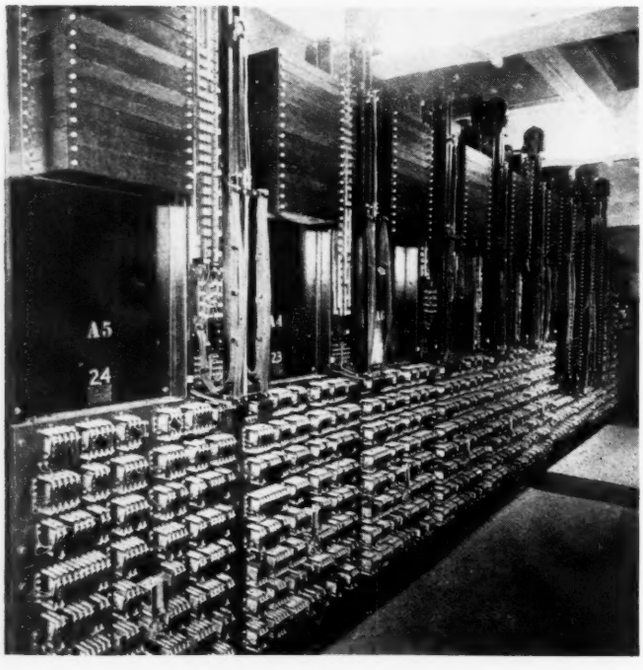
[1]B. basement; S.B. sub-basement. [2]Safe-lift capacity 6,000 lb.

next-floor-stop button, when pressed, causes the car to stop as quickly as can be done safely. Grouped below the car-operating lever are switches for starting and stopping the motor generator, car lights and fan, for closing the car and landing doors without starting the car, a hand-control pushbutton for use when inspecting the equipment emergency bypass on door contacts, and other devices.

On either side of the ground-floor corridor is a dispatcher's panel. At the bottom of one of these panels, Fig. 3, are the bypass lamps, one for each car, that light whenever a car has its quota and cannot take added calls. Just above these lights are duplicates of the automatic-schedule lights in the car. On the extreme left and right of the panel are up and down night floor-call annunciators, respectively. The two center columns are up and down day floor-call annunciators. Between the floor-call annunciators are eight light-column car-position indicators, one for each car in the bank.

At the top of the other panel, Fig. 4, are two cabinets, one containing the dispatcher's telephone and the other the dial, on the automatic-dispatcher, for setting the time interval between cars. Just below these cabinets is a row of buttons. Beginning at the left, the first button is for quota increase. When this button is pressed the quota of passengers taken by the cars will be increased by one. The second button when pressed cuts out the quota system.

Fig. 5—Relay panels at bottom with selectors above, between banks of quota-system relays inclosed at top



When an even number of cars is being dispatched, normally a car should leave the top landing when a car leaves the bottom. An uneven number of cars in service requires a car should leave the top landing one-half interval later than a car dispatched from the ground floor. The third button from the left when pressed causes this delay. Buttons 4 and 5 respectively are for instant dispatch top and instant-dispatch bottom. If these buttons are pressed the cars will be dispatched from the terminal landing on arrival. Or, they may be dispatched instantaneously in one direction and run on regular schedule in the other. On the extreme right is the button for cutting in or out of the night-service signal system.

The next lower row of buttons across the panel, one button for each car, cuts the cars into or out of the automatic dispatching system. Below these buttons are the key switches and lights in series with those in the cars, for starting the motor-generator sets.

A row of buttons below the motor-generator lights allows the dispatcher to bypass calls on the quota system. The lowest row of buttons on the panel is on the car-buzzer system, which allows the dispatcher to signal the operator.

Landing-Door Locks

Keys for opening the landing doors in emergency are in the large opening under glass at the bottom of the panel. If the car is not at the floor the landing doors cannot be opened with the door key until a second lock in the door jamb is opened with a Yale key. These two keys are kept under glass in the dispatcher's panel for emergency service. Attendants who have a need for it are provided with a key that will open the landing doors when the car is at the floor but they must obtain the emergency key to open the doors from the hall if the car is not at the floor.

On the left of the emergency key enclosure are two buttons for cutting in or out the day annunciator lights. Two buttons on the right serve a similar purpose on the night annunciator.

As the building has been in service for a short time its population, about 50% of normal, is not sufficient to give this new elevator system a thorough test. Neither has the equipment been in operation a sufficient time to determine all its possibilities for handling passengers efficiently. Experience to date, however, exceeds designers' expectations, and the equipment has untapped possibilities yet to be explored.

The architects of the International Building are Reinhard & Hofmeister; Corbett, Harrison & MacMurray; and Hood & Fouilhoux. John Lowry, Inc. were the general contractors for the building. Todd, Robertson, Todd Engineering Corp.; and Todd & Brown, Inc., are the builders and managers. Clyde R. Place, consulting engineer, in charge of the mechanical and electrical features of the project, also worked out the detailed plans and specifications for the elevator system. All required hoistway clearances, elevator machine rooms, structural-steel design for overhead work, pits and other parts were so arranged in these plans that no modifications were required after the elevator contract was finally executed.

"DEAR BOSS"

So you need money to make plant improvements? Here's a way to get financial blood out of the executive turnip

By E. J. Tangerman
Associate Editor

NO POWER engineer is expected to build a monument. Even when he builds a new power plant that looks like one, he can't be satisfied with it. Soon as it's finished, he has to start to work to make it pay, and then year after year, make it pay more and more. Every time a plant engineer whittles a little bit off power costs, it makes his company able to sell for a little less, thus makes the consumer's dollar a little bigger.

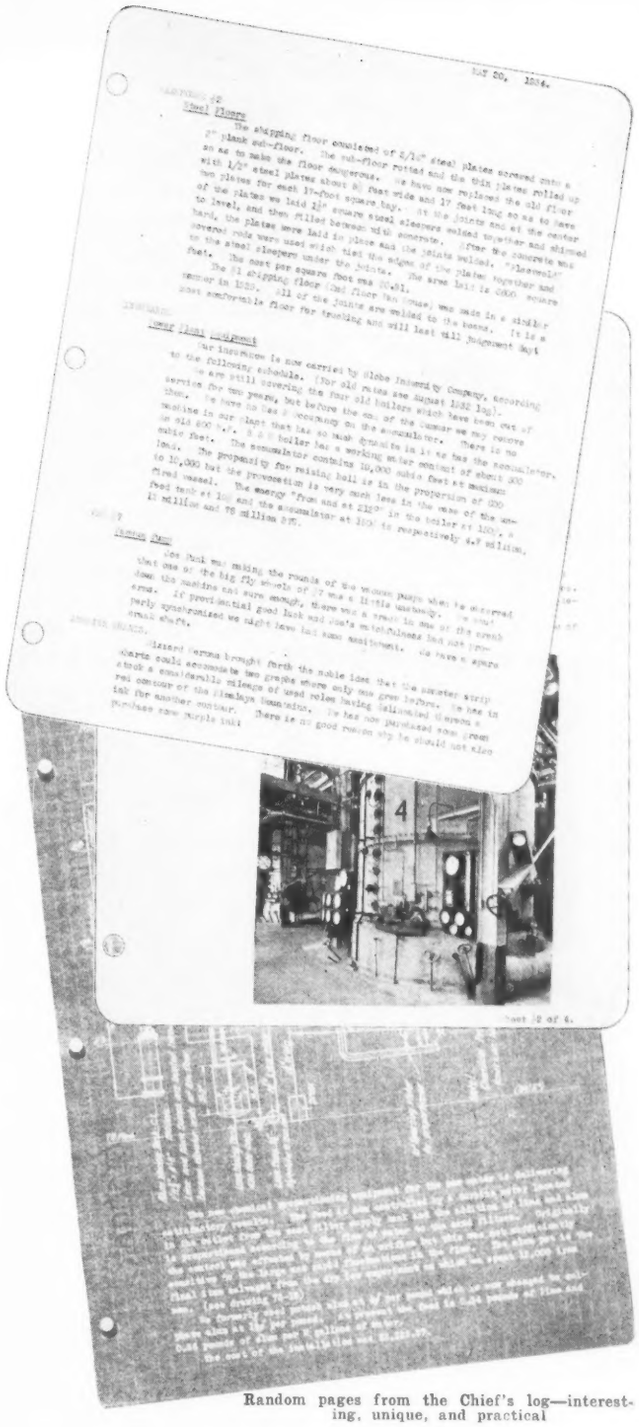
But to whittle a little bit off power costs in itself costs money. From some place or other, the plant engineer has to get the money to buy a new feedwater heater, to dig a new well, to repair a boiler. And while management is quite willing to accept any savings the engineer can effect, it isn't usually so willing to spend a lot of money to save—just on the plant engineer's sayso. Now how to get management's confidence, so it is willing to pay for the heater, the new well, the boiler repairs?

There is the rub, but one that many engineers have solved by a combination of hard, business sense, and the ability to make good on every economy they promise. Here is one that has been surefire for nine years.

This Chief knows his Boss, knows he's interested in things that happen around the plant, in what everything in the plant costs to build and to operate, in what the men are thinking and doing. So he becomes a source of expert data on everything that is going on. He keeps a "log" of that plant's doings, and sees that the Boss gets a personal copy.

At first he kept a diary, but that didn't work. Too often fragmentary reports didn't make sense, and when he wanted to check back on them he had to do a lot of painstaking rereading. So now he discusses a subject completely in one place, keeps an index, and from time to time brings that subject up to date. For example, two or three pages will discuss hoppers, giving sketches of typical hoppers around the plant, what they're made of, what they do, where they are, how much they cost, and how much it costs to keep them in shape. The next day it may be heat exchangers; another time tanks.

But how does that help the engineer get new equipment or money to repair the old? Like this: The Boss reads about hoppers, and forms an opinion. A couple of weeks or months later along comes another page or two of the log, explaining what's the matter with the hoppers as they are, how much it will cost to fix them, and how much it will save to make the changes. The Boss doesn't have to do any high-powered figuring—it's all down in black and white.



Random pages from the Chief's log—interesting, unique, and practical

For example, this Chief noticed a couple of years ago that his water costs were going out of line. So he discussed the water situation. Later he suggested that a well be dug, to cost so much, and to save so much. "But," asked the Boss, "How do I know you'll get water we can use?" "Next door," said the engineer, "they have a well giving the same water we'll get. Analysis shows it's okay for our use. So-and-so will dig the well at so much per foot. We should hit water at such and such a depth, making total cost so much.

"We'll need a pump and storage tank, which together will cost so much. Power for the pump will cost so much and maintenance so much. The well will save us about half our present water bill, and pay out in less than three years."

They dug the well, got water, cut water costs in half, and paid for the well in about 2½ years. A month or so ago water use jumped up again, and water costs reached their former peak. The Chief's log told the story and suggested another well. When the Boss saw the figures, he said, "Well, when are you starting that new well?"

Not so long ago, the Boss was walking through the plant and saw a new ball-bearing pillow block. "How much did that cost?" he asked. "$47," answered the Chief, "It goes in instead of that $7 plain block up there." "What!" yelled the Boss, "$47 to replace $7?" "With that ball bearing block, and ten more like it," explained the Chief, "I'm replacing all the pillow blocks on that drive. It used to require oiling three times a day, which for 11 blocks, is 33 spurts of oil, and with climbing up and down 33 times a day, about 4 hours of working time. Besides that, the oil either drips on the floor or into drip pans. A lot is wasted. I grease the new blocks twice a year. And the 250-hp. motor that used to drive this shaft is coming off, to be replaced by a 200-hp. That's 50 hp. in motor and power costs saved, more than enough to pay for the new blocks."

So the blocks went in. Like them, new things here and there throughout the plant. A few years ago, one little item was a new half-million-dollar boiler. This year, it will be a 2,500-kw. turbine-generator set.

Of course this wasn't built up overnight. The Chief kept sending copies of his log sheets in to the Boss for weeks before he read them. But they came so regular, and they bristled with so many facts and figures, that the Boss couldn't help reading them after a while.

Another secret of this log system is its brevity. The Chief "takes time to be brief." He may work for hours over one page to cut unnecessary words. He uses sketches, photographs, charts to save words. The Boss sees that, and appreciates it—in fact so much so that he sends in his chemist's voluminous reports for the Chief to boil down.

But even such meritorious reports might get slighted occasionally, if the Boss weren't human and the Chief didn't know it. All humans like gossip. The Boss is no exception. So the Chief puts in here and there, a little of the plant gossip. For example, "Sandy went up a ladder today with his flashlight in his mouth. Out dropped the flashlight, and Sandy's false teeth. Result: a broken suction cap." Now the Boss knows Sandy, and gets a little laugh out of it. Next time he sees Sandy, he says, "How're the teeth?" and keeps a friend.

Postscripts Too

That brings us to the next point in this unusual log. A few days later, the Boss sees a note clipped to the new log sheets, "Look back at such and such a date." There a neat postscript tells him that Sandy, being a good Scot, can't see the sense of paying good money to get his teeth fixed; he's found that chewing gum will hold them in. Again, six months later, he finds that Sandy has figured up the cost of chewing gum and paid money to get the teeth fixed. It keeps the Boss up to date and sells him on the virtues of spending a little money to save more.

Further, when the Boss sees a note to look back, it may be about Sandy's teeth, and it may be some up-to-date data on a problem discussed before in the log. He never knows which, but his curiosity makes him look.

At the end of the year, the Chief's log sheets show costs compared with last year, indicate the jobs he had to do at the beginning of the year, what ones he did and what they cost compared with estimates, and what ones are left to do. If he has a job to do and mentions it every year for several years, the Boss begins to wonder why he doesn't do it—and asks him why. That's just what the Chief is waiting for, and he explains that it costs money, and the Boss hasn't O.K.'d it yet. But the Boss has committed himself; he's worried about it, and sooner or later, he says "Oh Hell, go ahead!"

And another thing that is unique in records—when the Chief visits another plant, he reports what he's seen in his log, for his own benefit and for the Boss'.

Still another thing the log does is to give credit where credit is due. Some man away down the line in the plant thinks up a way to save a few nickels a day on something. Promptly it goes in the log, and the Boss learns that So-and-So had a money-saving idea. He begins to watch that man, and sooner or later, gives him his chance to make good.

Now for physical makeup of the log. It's typewritten with two copies, the original for the Chief, one carbon for a duplicate, and the second for the Boss. Blueprints and photographs appear alike in all three copies. Subjects are printed prominently in the margin so they can be picked up easily. Each copy is in a snap-ring binder, with an index in the front. There's a new volume every six months.

More Valuable as Years Go By

All-in-all, that log begins after a while to have immense value to the House and to the next generation of plant engineers. Over a period of years, it discusses very nearly everything in the plant and tells what troubles have been and how they were taken care of. That in itself is the answer to the amount of cost involved in keeping the log. It pays for itself dozens of times over in savings and in valuable records of plant design and operation.

And what of time for its preparation? We'll admit that is really the unusual factor. No plant engineer ever has time to get his work done, let alone keeping up a story book about it. So this Chief does it at odd hours, maybe at home, maybe on Sunday, or on days when work is slack at the plant. He gets his figures on costs from the company auditor—he even includes a record of days the plant operated, and what its production was, and at what cost for power per unit of product!

Perhaps then this is the answer to the monument problem. This Chief has not made his power plant a monument—for monuments are not being kept up to date constantly. His monument rather is a priceless record of what he and others have done to save money, where and what the bugs are, and how they can be ironed out.

NO MORE SMOKE

City officials "cracked down," so two old hand-fired H.R.T.'s in antique settings had to be modernized. Here's an account of the cut and try

By John D. Relyea
St. Mary's, Ont.

TORONTO officials recently became vigilant in enforcing the smoke law, which permitted 6 min. black smoke per hour. This was of course troublesome to plants which had been operating with hand-fired boilers. Our plant was among them, for we had two 1,500-sq.ft., hand-fired H.R.T. boilers in modified Hartford settings with side breeching running into an 80-ft. steel stack. Grates were of the rocking type similar to the so-called Manhattan design.

Installed in 1921, these boilers had only 28 in. space between shell and grates, aggravating smoke troubles. We were burning about 1,500 tons a year of long-flame Pennsylvania lump coal, of the following analysis: moisture 2.5%, volatile matter 29.0, fixed carbon 58.5, ash 10, B.t.u. value about 13,450, melting point of ash 2,300 deg. F.

Load was about half and half process and heating requirements, with an early-morning peak as plating and pickling tanks were brought to temperature. Ordinarily, process load was carried by one boiler at 100% rating.

Preliminary Changes

Preliminary changes involved no expense, but dealt only with methods. The night watchman was instructed to bring all tanks to temperature before the day shift arrived; thus any extra smoke occurred during hours of darkness. All coal was to be wet down before firing, slowing up initial combustion and thus evening up the air supply. More attention was to be paid to cleaning fires, particularly in removing clinker. This resulted in a more abundant air supply when fuel was added. A much lighter fuel bed was to be carried, to allow more air to get through to aid combustion. Firemen were instructed to open chimney dampers on firing and pay more attention to fire-door ventilators. The coking method of firing was adopted, combined with more skillful use of the hoe.

These changes might have been sufficient, but the plant was extended and production demands increased. One day, a summons from the Smoke Inspection Department resulted in a peremptory order from the management that excessive smoke emission must cease.

As an emergency measure, we shifted over to petroleum coke. This gave smokeless combustion, but at a decided increase in fuel bill and considerable damage to grate bars. A layer of broken firebrick over the grates minimized the difficulties there, but costs were still considered too high. Therefore, the next logical point to be attacked was the furnace or combustion space.

The supplementary combustion chamber back of the bridge wall was enlarged by digging it out to floor level, and the bridge wall lowered by two bricks and sloped from front to rear. Excavation required further bricking of the blow-off pipe. A steam jet was installed just above the fire door. When this is opened before firing, intensity of emitted smoke is noticeably reduced. We also installed an 18x24-in. copper-bound plate mirror on the wall of another building so that the fireman could see the top of the stack from in front of the boiler.

Experimented With Coal

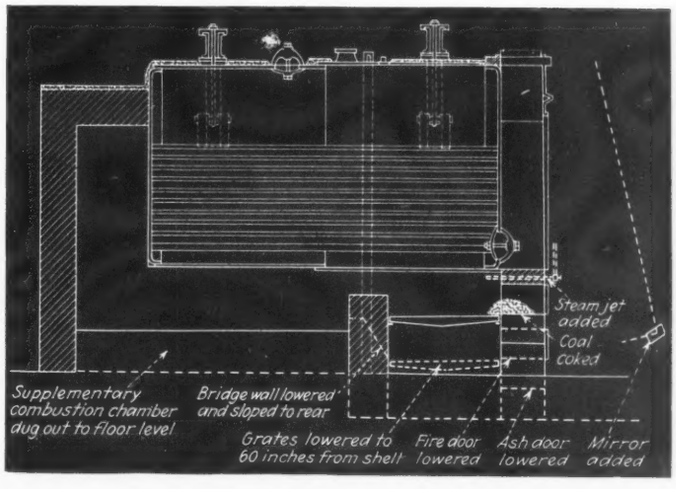
When these changes were completed, we shifted back to long-flame coal, but the set-up was too precariously balanced. Any little neglect resulted in black smoke. So we tried Pocahontas coal, with high cost figures, then various others, best results being obtained with those having lowest percentages of volatile combustible matter. Coals that clinkered freely and those with low ash fusing points were troublesome, largely through stoppage of the air supply.

Best results were finally secured with a 50-50 mixture of the long-flame regular steam coal and a so-called "smokeless" with relatively low percentage of volatile matter. Another coal that worked well was a Pennsylvania low-volatile of the following analysis: moisture 4.40%, volatile matter 22.44, fixed carbon 74.57, ash 6.59, B.t.u. value 13,840, melting point of ash 2,750.

The ultimate solution was lowering of the grates to 60 in. beneath the shell, which required us to cut away the foundation beneath the boiler front and to firebrick the side walls.

These changes, costing about $300 per boiler, eliminated the smoke problem and permitted use of cheaper coal. We found it possible to run the boilers at a higher rating, often carrying a heavy load on one boiler. This rearrangement also makes it possible to install stokers with minimum trouble whenever they become necessary.

Changes as indicated eliminated the smoke problem


Steam jet added
Coal coked
Supplementary combustion chamber dug out to floor level
Bridge wall lowered and sloped to rear
Grates lowered to 60 inches from shell
Fire door lowered
Ash door lowered
Mirror added

WHY COMPRESSED-AIR

Do leaky discharge valves create compressed-air temperatures high enough to cause explosions? Mr. Sandstrom says no, explains why not, and suggests alternate causes

COMPRESSED-AIR receiver explosions are usually attributed to leaking discharge valves which permit a portion of the high-temperature, high-pressure air to return to the cylinders. Subsequent recompressions are assumed to raise its temperature to the ignition point.

Whatever the cause of the high temperature, one other condition vitally necessary for an explosion is a correctly proportioned mixture of oil vapor and air. But the quantity of oil necessary for proper lubrication of an air compressor is so small that even its complete vaporization will not provide enough vapor for an explosive mixture. Thus when an explosion does occur, it obviously must be caused by too much oil.

Blaming leaking valves for high temperatures sometimes attained seems to imply that tight valves are the rule. But why should valves be selected as the culprits, and the rings be allowed to go scot free? Leaks through the valves or past the rings should be almost equally effective in producing the alleged results. Further, if leaky valves are the culprits, there should be many cases of overheating, for thousands of compressor installations are running under almost every degree of leakiness.

Do proponents of the leaky-valve hypothesis believe that all but a few compressors are tight? I have directed overhauling of several compressors; every one leaked badly. The leaks were shown in one case by an indicator diagram; in all by increased capacity after overhaul. To overcome the idea that a leaky discharge valve causes high temperature, block one open and convince yourself.

If recompression causes high temperatures, how about the air in the clearance space? This air, expanding to the suction pressure, is in some compressors more than 10% of the piston displacement. If mere re-expansion and recompression of air produces high temperature, here is a cause that is inherent in all compressors.

It seems to me that proponents of the leaky-discharge-valve hypothesis presume that work done on air as in a fan with the outlet closed, heats the air to a temperature limited by the radiation loss. Conditions are quite different in an air compressor, however, for a quantity of leakage air (only a small fraction of the total) is mixed with a large volume of cold intake air. The leakage air actually works against the intake air and piston, with consequent refrigerating effect.

Assume a single-stage compressor with valves that permit leaking back of 25% of the air which enters the cylinder. Ignore the refrigerating effect of the expanding air. Receiver pressure is 80 lb. gage. The piston completes the first stroke, and the air temperature, according to $T_2 = T_1\left(\frac{P_2}{P_1}\right)^{\frac{1.3-1}{1.3}} = 814.95$ deg. F. abs., T_1 being atmospheric temperature of 530 deg. F. abs., or 70 deg. F. The exponent 1.3 is the ratio of specific heats which is reduced from 1.41 by the influence of the jacket water and other heat absorption.

At the beginning of the second stroke, one-fourth of the air is from the clearance space and leakage through the discharge valves, the remaining three-fourths being air from the atmosphere, which is at 530 deg. F. abs. According to $\frac{PV}{T} = \frac{p_1 v_1}{t_1} - \frac{p_2 v_2}{t_2}$, the temperature of the mixture is 581.06 deg. abs. This air is compressed on the second stroke, with a resulting temperature of 893.45 deg. abs., or 433.45 deg. F.

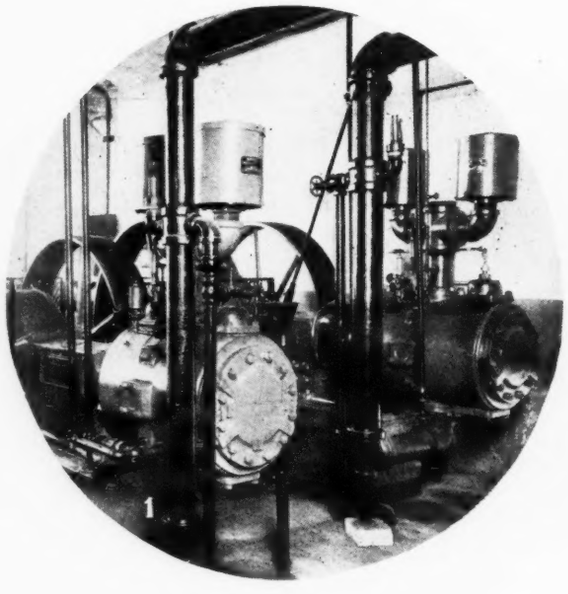
Table I—Temperatures at End of 7 Strokes

Strokes	$C_p/C_v = 1.3$ Temperatures, Deg. F.		$C_p/C_v = 1.41$ Temperatures, Deg. F.	
	End of Suction	End of Discharge	End of Suction	End of Discharge
1.....	70.00	354.95	70.00	451.32
2.....	120.76	433.00	131.91	557.75
3.....	129.94	447.10	142.41	575.80
4.....	131.48	449.47	143.85	578.27
5.....	131.71	449.83	143.91	578.384
6.....	131.76	449.905	143.911	578.397
7.....	131.77	449.916	.....	.....

Table I shows temperatures at beginning and end of each of seven strokes. There is a gradually diminishing increment of temperature rise until practical equilibrium is reached at the end of the seventh stroke, when the air reaches a temperature of 449.916 deg. F., an increase of only 0.011 deg. over the preceding stroke.

Assuming complete adiabatic compression; that is, with no cooling, and with 1.41 for the ratio of specific heats, the final temperature is 578.384 deg. F. at the end of the fifth stroke, and 578.397 deg. at the end of the sixth stroke.

Apparently recompression does not explain the high



EXPLOSIONS?

By C. O. Sandstrom

Mechanical & Structural Engineer

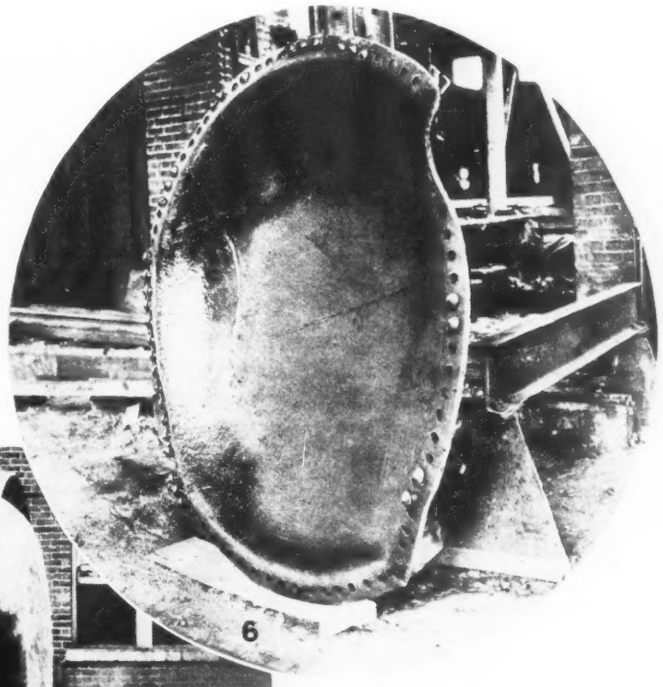
temperature necessary to an explosion. When, as is undoubtedly the case, work is done on the piston by the expanding air, with consequent refrigeration, the temperatures are still lower than those shown.

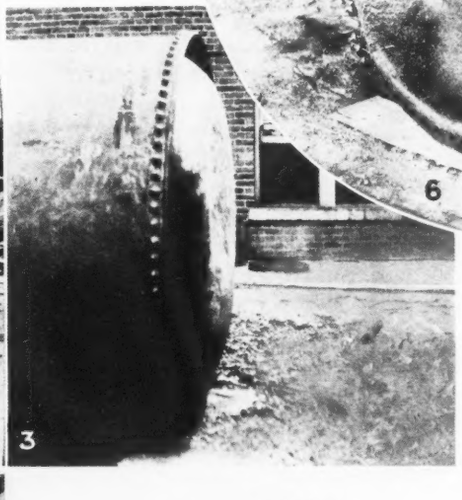
Another explanation of the high temperatures sometimes reached by compressed air is that of rapid oxidation of oil by the dense, or concentrated condition of oxygen in the high-pressure air. Dense air is inherent in air compression and oil is always present, so if this be the cause then high temperature should be the rule and not the exception.

Some of the high-temperature hypothesis advocates advance the claim that all air-receiver explosions occur just after the compressor, had been running at reduced capacity for a period. I do not recall that all receiver explosions that have been brought to my attention occurred just after the compressor had been running at reduced capacity, but I do recall, however, several that exploded shortly after starting up, after a period of idleness, which idleness may have been a contributing cause. In one case the receiver exploded 8 min. after starting the compressor in the morning.

Regulation of output of air compressors is accomplished in several ways, one method of unloading being throttling the inlet. This results in an increase of the compression ratio and, as an apparent consequence, increase of the discharge temperature. Assume a compressor operating with a 70-deg. suction temperature and a discharge pressure of 80 lb. gage. If the suction is throttled to one-half atmosphere, the calculated discharge temperature will then be approximately 495 deg. F. For 3 lb. abs. suction pressure, the discharge temperature becomes approximately 717 deg. F.

The latter temperature is higher than the flash point of good lubricating oil. If there is no open flame to ignite the vapor, there seems to be no point in emphasizing the importance of flash temperature. It seems then that we must look for other causes than the compression





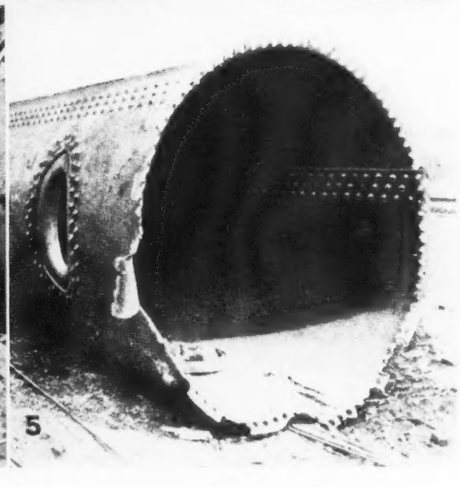


Fig. 1—Filters on air intake reduce compressor wear, keep dirt out of the air receiver, thus help to prevent explosions

Fig. 2—Wreckage after a 3x15-ft. compressed-air receiver exploded, killing seven men and injuring ten

Fig. 3—Explosion reversed this dished-in air-receiver head, but the receiver did not fail, for weaker parts of the system let go

Fig. 4—This 5½x17½-ft. air receiver exploded because a relief valve failed. It caused $9,000 damage

Fig. 6—Reversed bottom head (originally concave) of a vertical 5x13-ft. air receiver. Fig. 5, which pulled away from the shell in an explosion)

Explosion photographs courtesy Travelers Insurance Company and Hartford Steam Boiler Inspection & Insurance Company

ratios obtained in ordinary air-compression practice, since spontaneous ignition as in a diesel cylinder is hardly possible in an air-compressor cylinder. Furthermore, the small volume of air handled under throttled suction would lose a larger proportion of its heat of compression to the cylinder walls and, consequently, the delivery temperature would be considerably lower than previously given.

One make of air compressor is provided with an automatic clearance controller, which puts clearance pockets of about twice the cylinder volume into communication with the cylinder. Under partial load, a portion of the air is compressed into the clearance pockets, and on the return stroke gives up energy to the piston. Here is a very considerable leak which, if the recompression hypothesis is correct, should produce very high temperatures. As a matter of fact there is no abnormal temperature when the compressor is delivering no air at all.

Idleness itself is not a cause of explosions but, however, it may indirectly produce a condition that contributes to explosions. If certain types of lubricators are not shut off when shutting down the compressor, oil will drool into the cylinder and, when starting up again, will provide an abundance of oil for a fire or an explosion. Explosions that have occurred during periods of partial load may have resulted from an excessive supply of oil during those periods.

Pending accurate information of the cause, or causes, of air-receiver explosions, it seems to me that the best we can do is to pry loose from the operator's mind the notion that because a little oil is good, twice as much would be twice as good. The sloppy condition of a great deal of machinery attests the prevalence of the notion. I once knew an operator who, just prior to starting up a compressor, would "jiggle" the force-feed lubricator, "Just to give her a good shot of oil before starting up." I warned him that persistence in the practice would some day give him a good "shot" over into the next county.

It is my opinion that the cause of fires and explosions in compressed-air practice cannot be found in any single item of operating conditions, but must be sought in a combination such as: the normal high temperature of compression, the dense condition of the air and consequently its oxygen content, some cracking of oil and deposition of coke or carbon, adsorption by the coke of hydrogen sulphide (the latter an impurity in the lubricating oil), and the necessary reaction accelerated by a catalytic agent.

It does not seem reasonable that any one condition can be the cause of high temperature. With the thousands of compressors running under nearly every conceivable condition, there should then be a greater number of fires and explosions. When coincidence of several factors are essential to high temperature, then we can expect just what does happen—only an occasional fire or explosion.

It is a bit curious that there should be a cloud of mystery about the cause of compressor, or receiver, explosions. If any other industrial apparatus should manifest its defects by an occasional disaster, serious efforts would be made to find and remedy them. But in the case of receiver explosions, a known contributing factor is an excess of lubricating oil; so the operator is warned against this excess and is further admonished to keep the discharge valves tight.

This problem presents an opportunity for research beyond the abilities of the ordinary operator, so it seems that the manufacturers, or some department of the Government, is elected, or at any rate, nominated for the work.

A GOOD SHELLACKING DRIED THIS OIL

By G. Rosentreter
Riegelsville, Pa.

WHILE on duty a short time ago, I noticed a rise in oil level in one of our turbine reservoirs. Since we always carry oil level below a certain point, I tested immediately to see whether the additional fluid was oil or water. We found water in the oil, although all valves through which oil could enter were tightly closed, the oil coolers were tight (in fact oil pressure exceeded water pressure in them), and there was no outside source for the water. We immediately started to centrifuge, but found that water was entering the system as fast as we were centrifuging it out.

The only remaining possibility was the glands. Glands, bearings and oil wells beneath them were housed in, and condensate entered the glands to prevent steam leakage. Some of this leaked off and was carried away in channels provided for this purpose, but there was no evidence of serious leakage.

While searching for evidence of condensate entering the oil, we found a peephole in a casting beside one of the glands. With a flashlight beam, we could see a small section of shaft that looked bright due to the many particles of condensate clinging to it. Apparently condensate was leaking through the gland and creeping along the shaft to the bearing, then dropping into the oil well beneath and so into the main reservoir.

As soon as possible, we took the turbine out of operation and dismantled the bearing and gland. We found no evidence of leakage, so shellacked all parts and reassembled the gland. We checked the other gland, with the same result. Meanwhile, the centrifuge had cleansed the oil of water.

We started the turbine again and watched oil level, but it did not change. Through the peephole the shaft looked dull and uncovered by condensate. Apparently, although we could find no leaks, the fresh shellac had filled in minute holes through which leakage had occurred, and we had unconsciously overcome a potential source of more serious trouble.

SUSPENDED WALLS, ARCHES AND WATER WALLS

This supplement to the September, 1935, special section on Refractories lists additional types in current use

ALTHOUGH all suspended walls shown on the next two pages are built in sections or panels, each separately supported by castings in turn supported on steel beams or columns, they each have their design peculiarities. Section heights vary from 2 to 11 bricks high, some types having several heights of section so that lower heights can be used under severe service. An expansion joint between sections takes care of vertical expansion, and usually consists of offset tile construction with space provided for packing with asbestos or mineral wool.

Relative arrangement of offset and holding metal determines whether repairs must be made from the furnace side or from outside. When suspended walls are used behind water-wall tubes, as in Fig. 6, wall construction and repair must be done from outside the furnace. Most wall types can be arranged for this condition, and a few can be repaired from either side.

In all but two of the walls, each tile is held horizontally by a casting so that it cannot fall into the furnace. In three cases, these holding castings are free to move vertically and have considerable flexibility. In other walls the castings are bolted rigidly, thus fix exactly the position of each tile in the horizontal direction, while all tiles are free to slide vertically on the castings. Distance between hangar castings and dimensions of the tiles between adjacent castings are proportioned so that space is provided for horizontal expansion of each tile individually.

Wall tile shown in Figs. 2 and 3, instead of being held by castings, are held by special-shaped holding tile fastened to vertical steel work by bolted clamps. This construction claims the advantage of having no metal embedded in the wall tile and thus supporting steel and castings are more readily cooled. The arch made by this manufacturer is supported on the same principle.

Manufacturers differ as to methods employed to making the wall tight against air leakage. Some have straight-through joints and depend on special cements for making the wall airtight. Others use tile of special shape so joints are not straight through and so increase the resistance to air flow through the wall. The tongue-and-groove construction shown in Fig. 9 is intended to bond the tile together and so reduce air leakage. The slope or inclination of the tile in Figs. 4 and 5 is primarily intended to protect the asbestos in the expansion joint between panels from radiant heat and to keep asbestos that does fuse from running out of the joint.

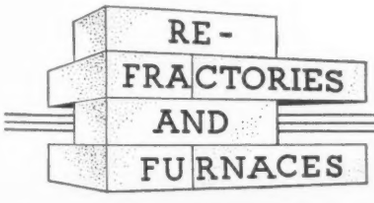
To permit higher combustion rates in boiler furnaces, modern units employ varying amounts of water-cooled wall surface. Tubes forming this surface are often left bare and placed on wide or close centers, depending upon the amount of water-cooled surface and protection to refractory backing desired. In certain locations in the furnace, such as at the clinker line of under-feed and chain-grate stokers, in the real wall at the ashpit, and where flame from pulverized-coal or oil burners is likely to impinge against the wall, the tubes forming the wall are protected. Types of tube protection not shown in the September, 1935, section are illustrated on page 138. They include both metal armor and refractory tile.

Metal armor is used along the clinker line of stokers to a considerable extent because it forms a hard and smooth wearing surface to which clinker does not stick. Metal protection is also used to protect the water-wall tubes in the lower portion of pulverized-fuel, gas and oil-fired furnaces. Figs. 20, 24, 28, and 29 show metal-block protection cast or fused on to the tube. In Fig. 29, where the tubes are closely spaced, the blocks are fused onto every other tube. Fig. 26 shows metal blocks bolted to the tubes, close contact with the tube being insured by special elements. When metal-block protection is used, the tubes are usually backed with plastic refractory, insulation and casing. Figs. 24 and 28 show the refractory, insulation and casing held in place by studs welded to the water wall.

Figs. 18, 21 and 25 show refractory protection. The refractory used in Figs. 21 and 25 is silicon carbide. Refractory-covered water walls are frequently required in installations using pulverized anthracite. Sometimes it is found that too much bare surface has been provided for good combustion at low ratings. An advantage in such cases claimed for the construction in Fig. 25 is that it can be put on over the tubes from inside the furnace without disturbing the rest of the wall. It is claimed that the heat stored in the refractory promotes ignition because of radiation back to the furnace.

Fig. 18 shows a type of construction used on water-cooled arches over chain-grate stokers in which the tubes are not completely protected, as slag fills up the space between and forms a covering surface.

A somewhat different arrangement of bare water wall is shown in Fig. 19. Tubes are placed some distance in front of a refractory wall which is claimed to reflect radiant heat received from between the tubes against the back side of the tubes, thus increasing the heat absorbed by them.



TYPICAL SUSPENDED WALLS

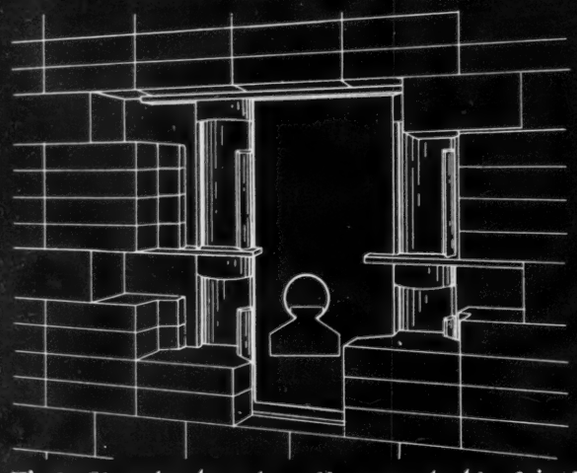


Fig.1 - Standard arch wall supported by 6-inch pipe

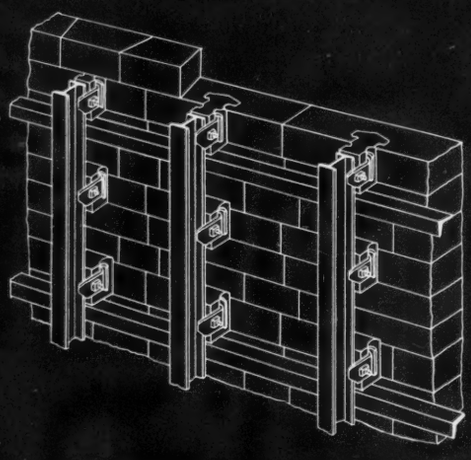


Fig.2-DeWolf Furnace wall for medium duty

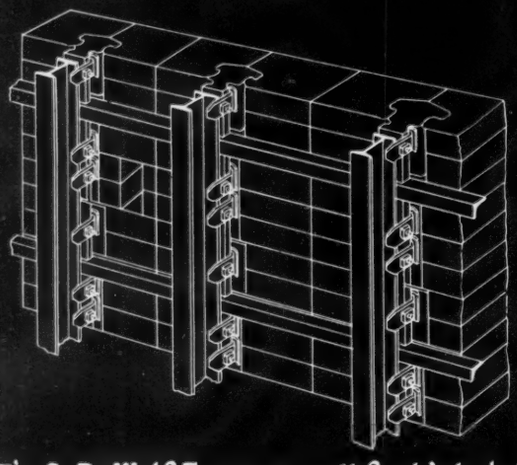


Fig.3-DeWolf Furnace wall for high duty

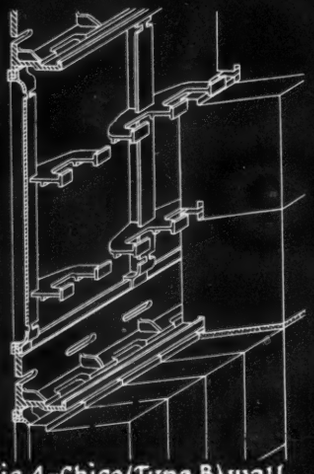


Fig.4-Chico(Type B) wall with movable horizontal support castings

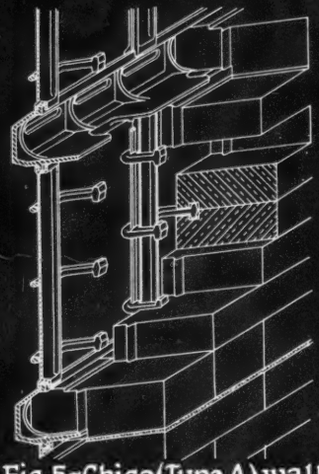


Fig.5-Chico(Type A) wall can be arranged for either horizontal or vertical air flow

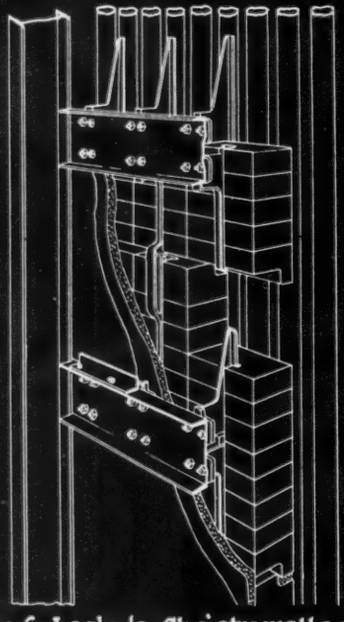


Fig.6-Laclede-Christy wall arranged for assembly from outside the furnace

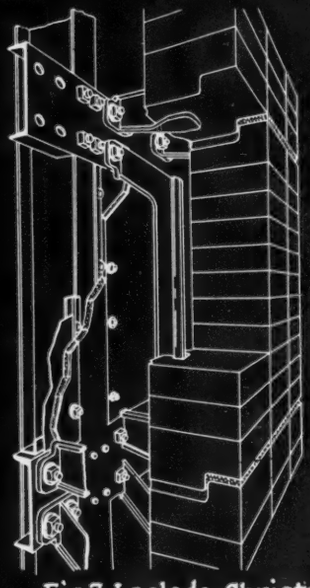


Fig.7-Laclede-Christy wall with insulation

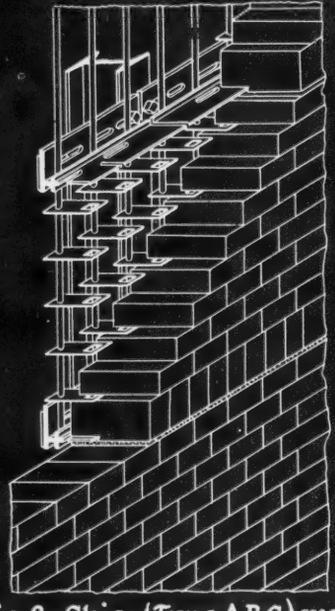


Fig.8-Chico(Type ABC) wall for insulating refractory

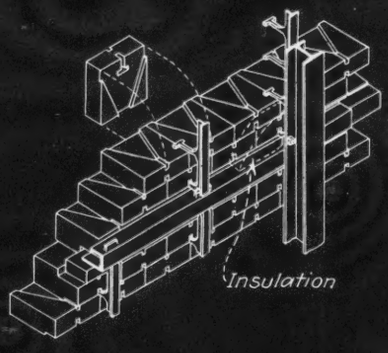
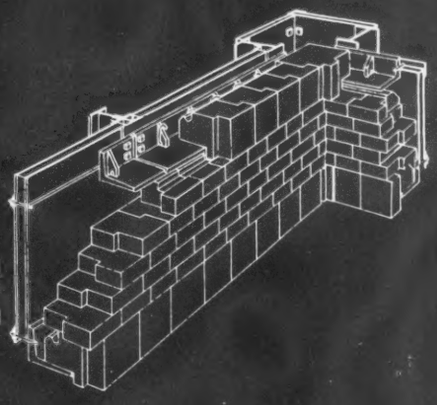


Fig.9-Simplex Engineering wall with tongue-and groove joints

Fig.10-Kennedy-Van Saun wall arranged for horizontal air circulation



TYPICAL SUSPENDED ARCHES

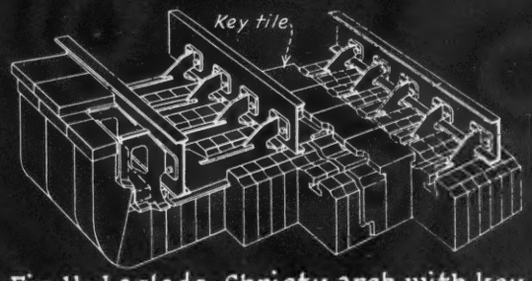


Fig.11-Laclede-Christy arch with key tile for easy access

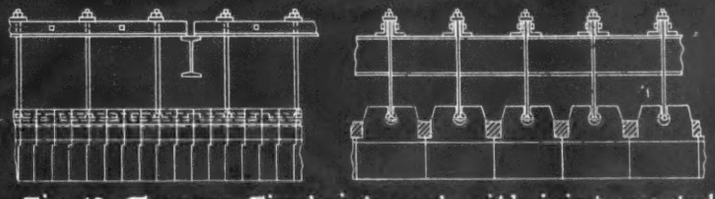


Fig. 12-Thermo Firebrick arch with joints sealed by soaps and offset in tile

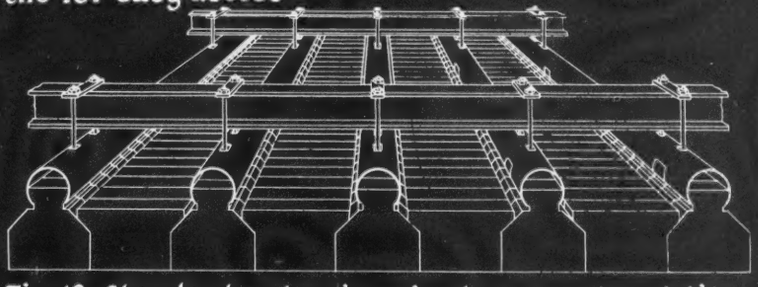


Fig. 13-Standard arch using pipe to support arch tile

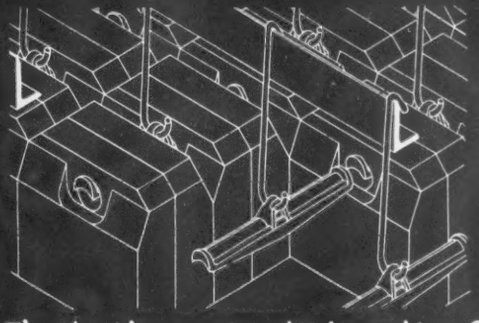


Fig.14-Chico arch built in units of four tile

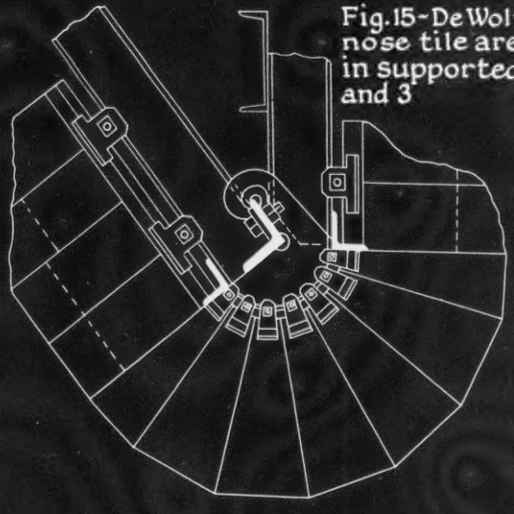


Fig.15-De Wolf Furnace arch nose tile are supported as in supported wall, Figs. 2 and 3

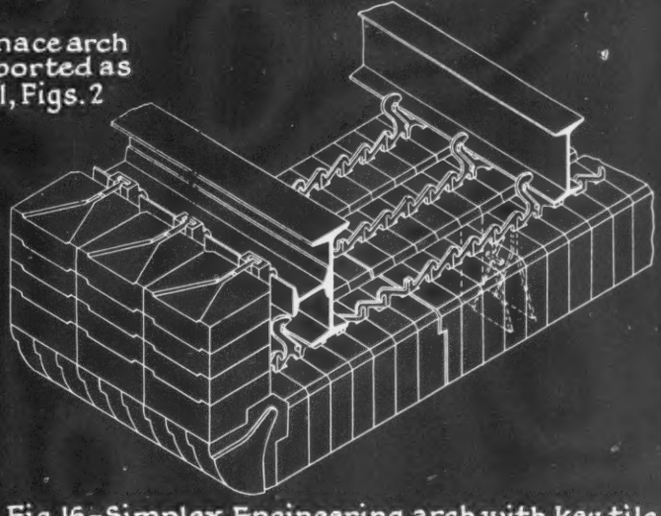


Fig.16-Simplex Engineering arch with key tile for easy removal of burnt brick

TYPICAL WATER WALLS

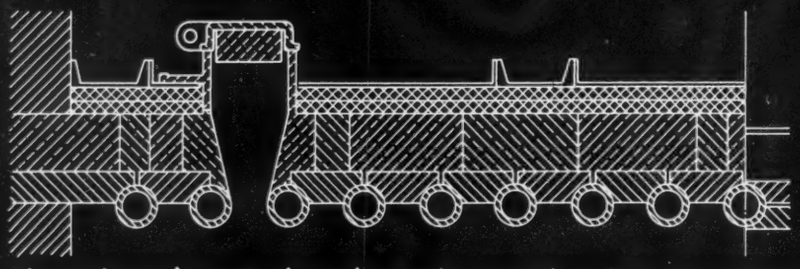


Fig.17-American Engineering T-tile backing for rear water wall

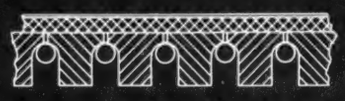


Fig.18-Springfield tube protection for arch over chain-grate stoker

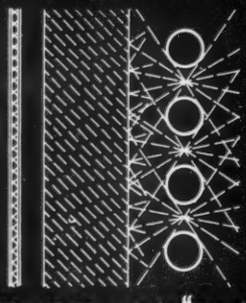


Fig.19-Kennedy "Shadow Wall" designed to increase heat transfer to water tubes

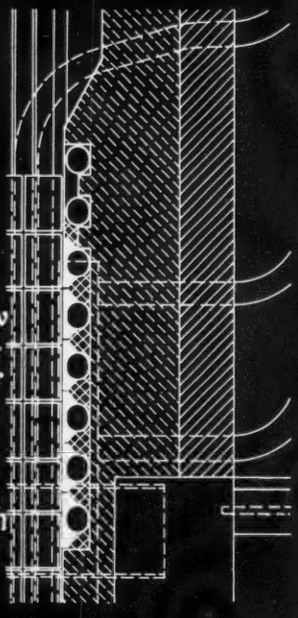
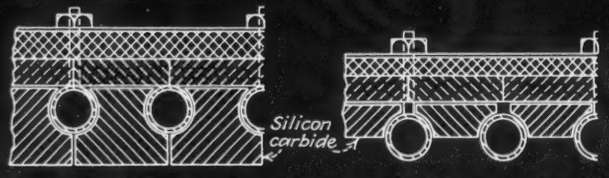
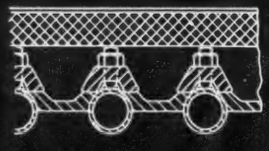


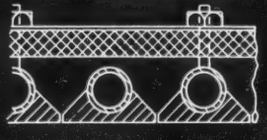
Fig.20-Springfield inclined side wall with metal protection fused onto tubes



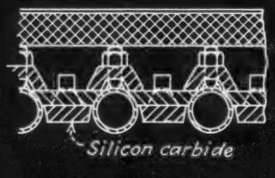
Figs. 21 & 22-Drake silicon-carbide protection for water walls

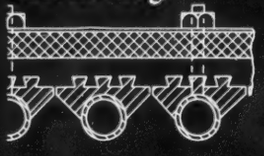


Figs. 23 & 27-Drake metal protection held against tubes by bolts spot welded to the tubes



Figs. 24 & 28-Drake metal protection fused to tubes and backed with plastic refractory





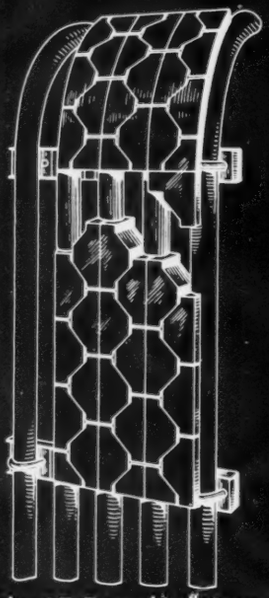


Fig.25-Bernitz "Nygaard" wall protection of silicon-carbide refractory

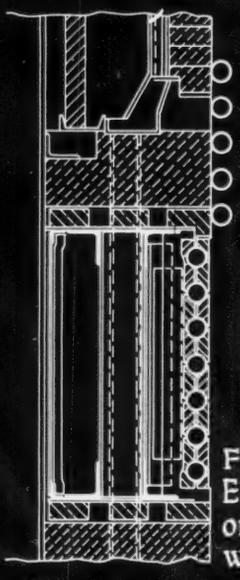


Fig.26-American Engineering armor on inclined side water wall bolted in place

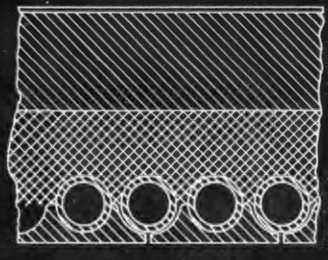
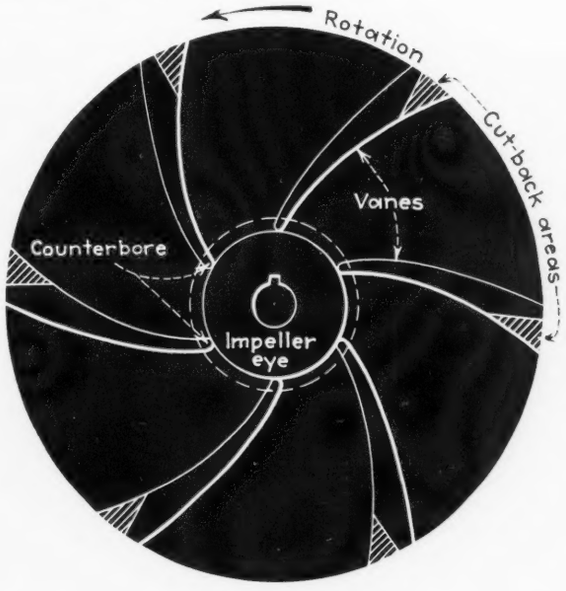


Fig. 29-Springfield armor fused on to every other tube

Fig. 1—Possible impeller-vane changes



TO INCREASE PUMP CAPACITY

By Frank A. Kristal
Mechanical Engineer

PIPELINE corrosion may increase friction head, suction-tank level may drop, or other conditions may change so that a centrifugal pump no longer delivers the capacity or head required of it. If the desired head or capacity isn't too much greater, minor changes in pump or impeller may permit the unit to meet the new conditions. Let's take an example:

Assume the full-line curves of Fig. 2 represent characteristics of a 6-in. centrifugal pump with original capacity of 800 g.p.m. and 90-ft. total head. But for some undetermined reason a vacuum gage on the suction and a pressure gage on the discharge now indicate total head of 95 ft. The pump's characteristic curve indicates that it is now delivering only 680 g.p.m. Nothing much can be done about pipe corrosion except to change the piping, an expensive business. If suction-well level has dropped, you probably must likewise accept the situation. A less expensive way to correct the condition is to cut back the impeller vanes at their discharge ends, as manufacturers do when their tests indicate slight under-capacity.

Fig. 1 shows an impeller cross-section with the original blade outline in solid lines. By chipping or filing the vane backs as indicated in shaded sections, the capacity of the pump comes back where it should be.

The amount to cut the vane ends back must be determined by cut-and-try. Apparently the passages between vanes act as nozzles, so cutting back the vanes opens up these nozzles and increases capacity for given head. My tests on this method have seldom indicated any change in efficiency, except to improve it—in fact in some cases manufacturers have taken advantage of the cutback idea in making later impellers for the same pump. While any good mechanic can do the work, it is advisable to do it only on the advice of the pump manufacturer, or to let him do it.

Sometimes the same result can be obtained by counterboring at the eye of the impeller, as shown by the dotted circle in Fig. 1. On many-bladed impellers, blade tips may be so close together that they restrict flow, and counterboring tends to open these passages.

Sometimes also there may be a head loss at the impeller entrance due to the rotational velocity of entering liquid, which may be regained by installing guides at the impeller entrance to straighten out the flow. Attach these guides to the pump casing or stationary wearing rings and extend them into the pump suction chambers.

Wear between impeller and case rings may also decrease capacity, permitting short-circuiting of flow from the discharge back to the suction. In the pump discussed

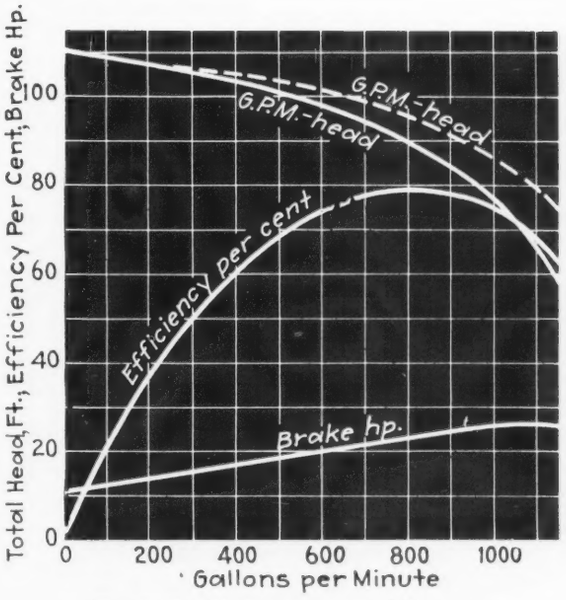


Fig. 2—Centrifugal-pump characteristic curves

previously, about 40 lb. difference in pressure exists between the discharge and suction sides of the impeller, so any appreciable wear on the 6-in. impeller or case rings would premit appreciable short-circuit loss. Repairing or replacing the worn rings is the obvious answer here.

TRIPLE USE ON CHARTS—One chief engineer has found that ammeter strip charts can be re-used twice over with inks of another color than that of the original record. If the first record is in red, then green and purple are possibilities for the second and third runs. After that, lines begin to cover one another.

7 YEARS AT ROCKY RIVER

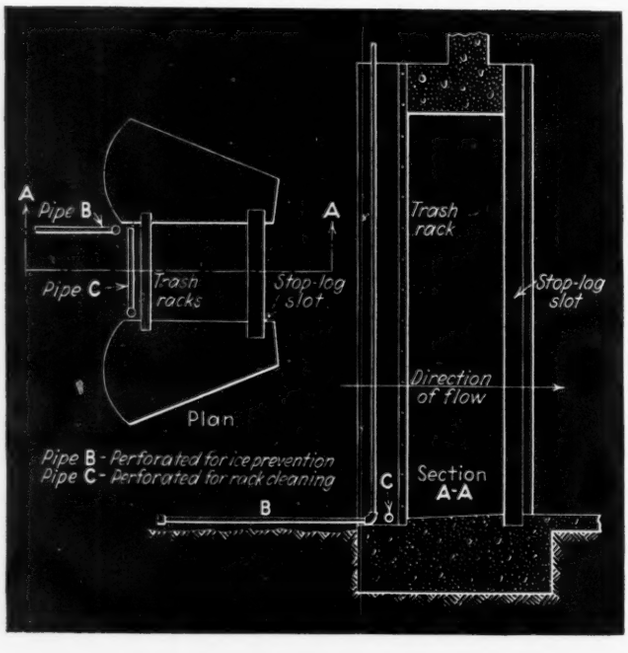
CONNECTICUT Light & Power Co. has developed operating practices at the 30,000-kva., pumped water-storage, Rocky River plant during the past seven years which make it highly effective in standby service. The project comprises an earth dam 100 ft. high and about 1,000 ft. long. From it a 2,800-ft. canal leads to a circular intake tower containing trash rack, stop logs and main gate which closes off a concrete conduit running through the earth dike. From the face of the concrete conduit, a steel and wood-stave penstock leads to a surge tank on the bluff above the station. Headworks and conduit facilities are large enough to care for a second generating unit.

From the Y at the lower end of the penstock, the main pipe runs to the vertical-shaft Francis-type turbine (single oil-lubricated bearing), the branch to two 250-sec.ft. pumps. A cylinder gate reduces leakage inherent with ordinary movable-wicket gates. Between pumps and river are gates operated by the main crane, and below each pump is a suction bell from which water can be forced by compressed air to reduce starting loads. The single-suction volute pumps are driven by 7,900-kva. synchronous motors mounted vertically on the common shaft. Each pump has a 54-in. pivoted valve in its discharge. Two 150-kw. motor-generator sets excite the pump motors, operate d.-c. auxiliaries, and serve as spare exciters for the main generator.

Pumps are started dry, air pressure of about 8 lb. being maintained in the suction. Cooling water is admitted to packing box and wear rings, and the starting switch closed. When the pumps attain speed, the field is closed, the starting switch opened and the running switch closed in the usual way. Water admitted to the pump builds up pressure in the closed discharge line; then the pivoted valve is opened. Gross head is about 230 ft. with a full reservoir. When a pump is closed down, its valve is closed, then running and field switches opened.

Pump motors, designed to operate at 80% leading power-factor, have proved useful as synchronous condensers. To operate as a condenser, the gate in the suction is closed and the pump drained into a sump and then started in the usual way, leaving the discharge valve closed. Water is necessary to lubricate the pump stuffing box and wearing rings.

Air pipes in intake keep racks free of ice and debris



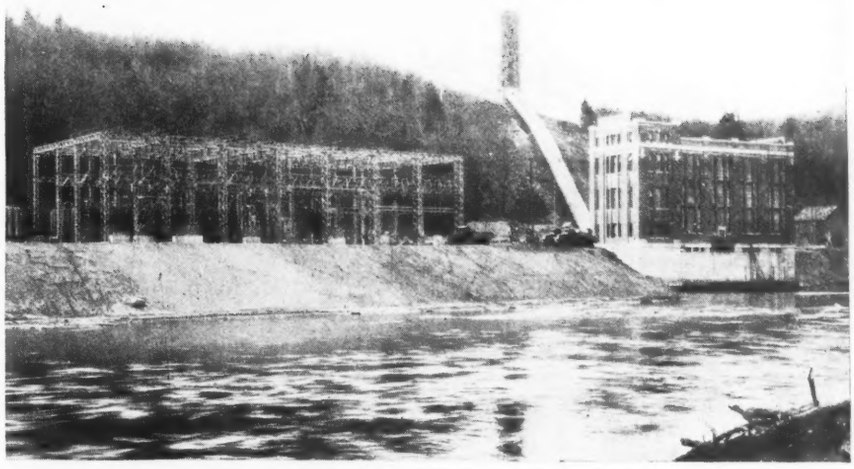
Operation of Main Unit

The main generator is relied upon as system stand-by, even when shut down with the cylinder gate closed. On this account, speed in getting the generator on the line is essential, and a starting routine has been developed with this in view. The procedure follows:

On receipt of instructions to put generator on line, the operator signals the floor man and starts up one motor-generator set. He then energizes the governor oil-pump circuit, which also starts the emergency oil feed to the turbine guide bearings. The floor man raises the cylinder gate. When this is nearly open, he starts the machine on hand control; the operator closes the 13.2-kv. circuit breaker (the high-side breaker is open), closes the exciter switch and starts to build up voltage. Then the operator plugs in the synchroscope, which is also connected to a synchroscope on the floor near the governor. Using hand control, the floor man regulates machine speed to facilitate phasing-in by the operator. As soon as the floor man observes that the machine is synchronized, he changes from hand to governor control; then takes care of the cooling water, checks oil flow, etc. These operations have been accomplished in one minute under favorable conditions.

During electrical storms and at other times of system stress, the generator is put on the line. On account of the wheel setting, it is impossible to clear it of water by letting air into the runner. It is therefore more eco-

Only important pumped-storage plant in this country, Rocky River is a highly effective standby unit. Here are operating practices as outlined by E. B. Ripley, superintendent of production for Conn. Light. & Power Co., before the New England System Operators' Club



Rocky River, 30,000-kva. pumped-storage hydro-electric plant

nomical to operate at about 2,000-kw. load than to motor the unit. During high water and low steam load, it has been necessary and economical to do this for voltage regulation and standby purposes.

Much of the penstock between reservoir and plant is above ground. In sub-zero weather, it is necessary to operate the machine at least once every 8 hr. Under normal conditions, the unit is put on the line and run for about 5 min. at sufficient gate opening to cause a water change in the surge tank and penstock. Compressed air is supplied to the surge-tank and intake tower bottom, as in the diagram; also at the gate openings of the latter to prevent ice formation. A 1-cyl., 5x6-in. compressor with a 15-hp. motor ordinarily furnishes enough air. During extreme weather of the last two winters it was necessary to start a second compressor for short intervals.

Operation has been entirely successful, except in penstock vents. These are about 3 ft. square in cross-section. In extreme weather, a kind of snow-ice builds up in them above the water level. Compressed air is not effective in breaking it up, making it necessary to poke out this ice with poles to clear the vents.

Earth Structure

The earth structures are composed of rock flour, on which little vegetation will grow. Erosion made it necessary to loam their entire surface. At present, barring some difficulty with rabbits and woodchucks, the structure requires very little maintenance. While tall, sweet clover was useful to get vegetation started, it has since become something of a nuisance. Stalks left in the fall seem to prevent growth of a good grass covering the following spring.

Drains are provided below all earth structures. Weirs at the outlets of these drains permit a record to be kept of monthly flowage at each. Well pipes in the earth structure are so arranged that three or four pipes are in one cross-section through the dam. From monthly readings in these pipes, a cross-section can be plotted which shows water-gradient elevation through the earth structures. These readings are checked locally and are then sent to the Waterbury headquarters for recheck so that any variation or unusual weather conditions can be quickly spotted. A semi-annual check of alignment and settlement of each structure and a close inspection of the entire property, are made, sometimes in company with outside consultants. In all cases seepage is gradually decreasing, and there is no indication of settlement or movement.

While Rocky River plant operation resembles in many ways that of any seasonal storage of limited capacity, a feature is that the reservoir holds about four times as much water as will run into it from the drainage area in any one year. The reservoir can always be refilled by pumping with surplus hydro, if available, or by using fuel-generated power, at a price. Thus far, all pumping has been done at times of high river flow. Early discussions of the plant's economic value emphasized its use as a kind of storage battery, generating during high-load portions of the day and pumping during periods of low load at night, regardless of river flows. This has not yet appeared economical.

It is obviously better to use energy to supplement kilowatt-hours from an inefficient turbine than to use it against the highly economical mercury generating unit at Hartford, via the exchange pool. If the Rocky-River unit can be run so that a turbine and a couple of boilers can be shut down for a time, a further saving can be made. When load conditions and available water permit, still further saving can be made by shutting down a unit for a year, avoiding certain operating and maintenance charges. This procedure is not possible with present loads and plant capacity.

The company therefore attempts to operate the plant at the time when it can get the largest number of hours of shutdown with the least expenditure of energy from the reservoir. Each year an estimate is made of the system peak and the amount of energy in it. A decision is made as to the number of steam turbines required, and Rocky River is run whenever necessary to keep the peak down to that figure. Sufficient water must be retained to cover possible emergencies and to meet the system peak in November and December. The tendency thus far has been to be a bit over-cautious in this regard, so that maximum possible benefit from use of the available water is not obtained.

POND COOLING BY SURFACE EVAPORATION

Analysis of data from many central stations which permits prediction of lake temperatures within 5 deg. under the given conditions

By D. O. Lima
Oklahoma Gas & Electric Co.

NATURAL evaporation of water, factors involved, and results to be anticipated, have been of considerable interest in certain localities for many years. Due to the scarcity of surface water in the Southwestern United States and Northern Mexico, the establishment of industrial activity has lagged in this area as compared to areas where water is plentiful, to such an extent that its manufacturing importance is comparatively negligible. In the past, considerable attention has been devoted to rainfall by the U. S. Weather Bureau, and stream flows in various sections of the country have been reported on by the U. S. G. S. This information, together with data by Turneaure & Russell (Ref. No. 3), will give a fairly comprehensive picture of the situation as regards potential water-supply developments.

A large portion of this so-called dry area receives annually a quantity of rainfall comparable to that received by many of the rich agricultural sections east of the Mississippi River. However, due to soil conditions, topography, lack of forests which would aid retention, and the fact that the greater part of this rainfall is experienced over a very limited period of time, the moisture is lost to usfulness, resulting in a dearth of surface water. A certain amount of water is available from wells, but experience indicates: first, that the unit capacity per well is comparatively small, resulting in considerable development expense for large quantities, and second, the underground storage is limited as indicated by a more or less rapid lowering of the water table in areas where several wells are being pumped.

Obviously, with considerable rainfall it follows that the most economical and dependable source of water supply is reservoirs of a capacity that is consistent with the demands to be imposed upon them, the stored water, augmented by low-capacity streams or wells, to carry the demand over the dry periods. This scheme is generally used by the larger cities in the Southwest, but in many cases the expense of obtaining an adequate domestic and commercial supply has been high, thereby limiting the quantity available for industrial use. The result has been that industries which require large quantities of water have either moved elsewhere or have been forced to develop their own supply independent of other developed sources.

A specific example of an industry that is required to develop large sources of water supply is the electric light and power industry. Due to the lack of potential hydroelectric sites and transmission limitations, it has been necessary to produce practically all power consumed in this district by steam plants, which in turn require a continuous flow of large quantities of cooling water through the condensing apparatus. If this water can be cooled after passing through the plant, it can again be used with a loss per cycle of only the amount of water necessary to cool the total quantity by evaporation, plus windage and waste, plus natural evaporation. In modern installations, these losses will usually run less than 5% of the total amount of water handled by the station. This cooling can be practically accomplished in three ways, i.e., cooling towers, spray ponds, and recirculation.

Cooling towers and spray ponds, while more efficient in the matter of temperature drop, have two inherent economic disadvantages; namely, first cost and operating costs. Assuming that there is a possible location near the load requirements where recirculation can be adapted, which is generally the case, the use of cooling towers or spray ponds is economically precluded. However, due to the necessity of some investment in development of recirculation sites and attendant expense in connection with a specific power-plant location, it is necessary that the potential cooling capacity be approximated. Where the required heat dissipation can be easily calculated, no information has been made generally available to engineers as to the performance to be expected with given heat dissipation. This article is the result of considerable investigation and study, having for its aim the coordination of actual operating data with conditions in such a way that operating results can be reasonably accurately forecast.

In most cases the location which most conveniently and economically lends itself to recirculation of cooling water in large quantities in level country is a large bend in a stream bed, either one which the stream follows naturally when water is flowing, or a bend which has been cut off from the main stream. With this arrangement the water can be taken from one terminus of the bend and discharged into the other, thereby forcing all the water to traverse the entire distance around the bend before it can reenter the power plant. In order to hold the construction costs of intake and discharge facilities to a minimum, these intake and discharge points should be as close together as possible. On locations where such a site is not available, a dam strategically located so that it will form a lake will serve equally well, although this usually entails considerable expense in forcing the water to travel the required distance between discharge and intake. This can be accomplished, however, by artificial barriers such as earth fills or sheet piling.

Recirculation can also be successfully applied to a body of water without forcing recirculation by barriers, provided the discharge or hot water is delivered to the surface while the intake is at a considerable depth. The hot water will spread out over the surface of the lake, and as it is cooled a convection circulation is set up which will supply the intake with the coolest lake water available. A strong wind away from the discharge and towards the lake aids in distributing the warm water, while a wind in the opposite direction hinders somewhat.

In studying the potential cooling capacity of a recirculation scheme, the first factor which must be determined, of course, is the make-up water requirements. This can be done with a fair degree of accuracy by determining the natural evaporation for the area in question (either by experiment or from published data, see Ref. 1, 2, and 3), and adding the quantity of water necessary to dissipate the heat which will be added by the generating station, plus estimated seepage. This last factor is of indeterminate value and depends on the soil structure and general topography. In most cases, the seepage and loss of water due to wind, other than evaporation, can be neglected. When the make-up quantity has been determined and a source of supply assured by wells, stream flow, or storage capacity, the next step is to determine the capacity of the reservoir with given plant conditions for certain inlet cooling-water temperatures. Many variables were encountered in attempting to estimate such values during 1920 to 1925 when additional plants were required, and in most cases liberal allowances were made for these variables in plant design without further attempt to forecast operating results.

By the year of 1928 several such plants had been constructed and were in operation, and it was agreed by engineers connected with the various companies operating these plants that data would be interchanged on the operating results with the object of comparing the variable factors involved in cooling by recirculation. In this manner it was hoped that it would be possible to correlate these data in curves and tables in such a manner that engineers would have a ready reference for estimating probable operating results on future plants and extensions.

The following gives a summary of the results of data interchange as interpreted by

the engineers of our company. Some of these data have been published heretofore (4).

The cooling effected by recirculation is herein referred to as a coefficient K, and this is defined as the B.t.u. liberated from 1 sq.ft. of water surface each hour per inch of mercury vapor-pressure-difference between water at the mean lake temperature and water at natural equilibrium temperature. In other words, K is the hourly heat input per square foot of lake surface divided by the inches mercury by which the vapor pressure of water midway between inlet and outlet temperatures exceeds the vapor pressure at the temperature the lake would assume if it had no heat artificially added to it.

Fig. 1 shows for easy comparison the results of all data received as curves for K versus air temperature for a wind velocity of 6 m.p.h., 5 ft. above the lake. Fig. 2 shows K for a 6-mile wind plotted against heat input, each curve being for a different air temperature. Points plotted in this graph were calculated by averaging K for several lakes having nearly the same heat input. In Fig. 3, data from Fig. 2 has been recalculated on the basis of heat input, air temperature, and mean lake temperature, cooling coefficient K having been eliminated. From Fig. 3, if any two of the three factors are known or assumed, the third may be read directly. Assume the heat input is 80 B.t.u. per sq.ft. per hr. and the air temperature 80 deg., find the mean lake temperature. Locate 80 on the input scale, pass vertically up to the 80-deg. air temperature on the ordinate and read lake temperatures, which is about 95 deg. With this set of conditions, if the temperature rise of the circulating water through the condenser were 10 deg., the inlet would be 90 deg. and the outlet 100 deg. If the rise were 16 deg., the inlet would be 87 and the outlet 103 deg. Fig. 3 holds true only for a wind velocity of 6 m.p.h., 5 ft. above the ground. Also, it will not give reliable instantaneous temperatures, but only averages for a period of time long enough to iron out the effects of daily variations in weather and the lag between air and lake temperatures.

When the study of lake cooling of circulating water was begun, many problems arose as to what factors should be taken into account and how the cooling effect should be expressed. Relative humidity, wind velocity, effects of trees or high banks on wind effect, heat from the sun, and percent of sunshine time, arithmetic versus logarithmic mean temperature or vapor-pressure differences, and the effect of high or low temperature rises through condensers were the main problems. It was finally decided that the equilibrium temperature of water exposed to sun and wind would give the integrated effect of air temperature, humidity, sunshine and wind on water not artificially heated, and that this equilibrium temperature could be easily obtained by installing a recording thermometer bulb in a shallow insulated tray of water mounted about 4 ft. above the ground. It was, however, considered necessary to use anemometers and take wind velocity into consideration when dealing with the cooling coefficient itself, because water which is heated above its equilibrium temperature tends to give off water vapor at a higher rate and to saturate the adjacent layer of air much more quickly, and hence the higher the wind velocity the better the evaporation and cooling, while in the case of water at equilibrium temperature any wind in excess of that which cools it to the wet-bulb temperature can have no further effect in reducing its temperature.

In this study the heat inputs were, for simplicity, assumed to be 1,000 B.t.u. per lb. of steam going to the condenser.

In the early part of the study it appeared

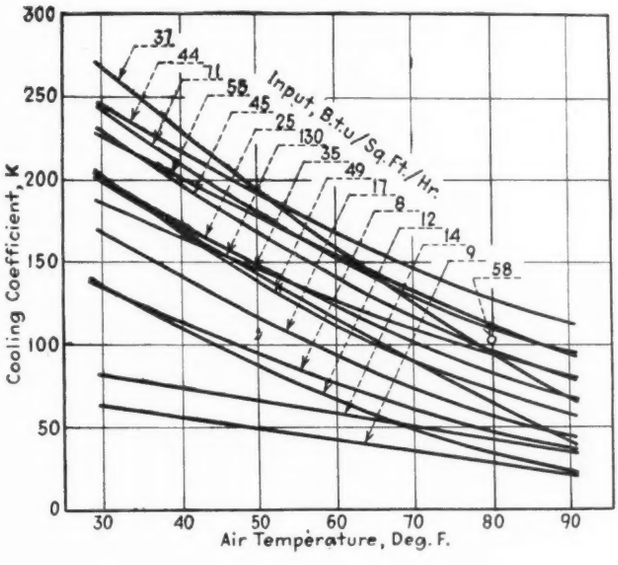


Fig. 3 (Below)—Recalculated curves showing mean lake temperature vs. heat input and air temperature—wind velocity 6-mi. per hr.

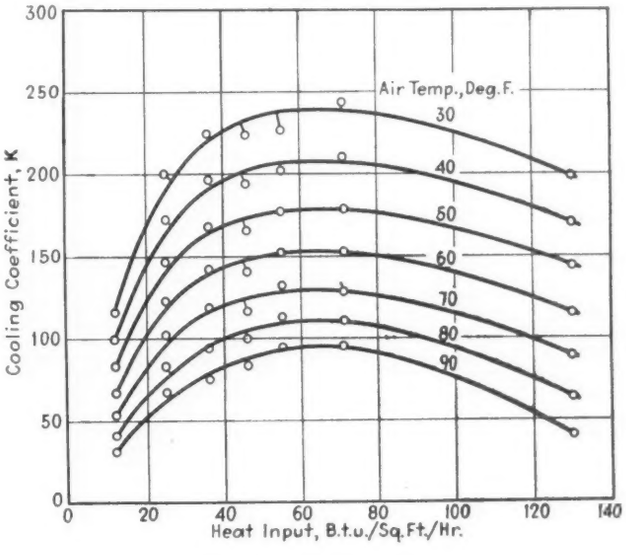
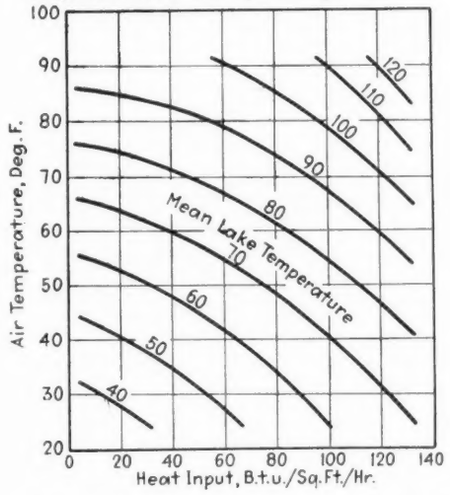
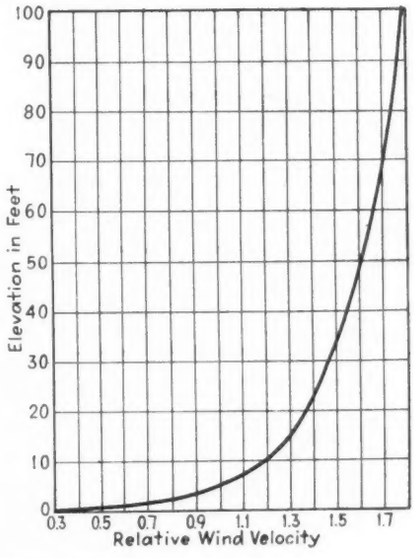


Fig. 1 (Left above)—Summary of data from all lakes showing cooling coefficient for a 6-mi. wind vs. air temperature

Fig. 2 (Above) Averaged curves from all lakes showing the cooling coefficients for a 6-mi. wind vs. heat input, for various air temperatures





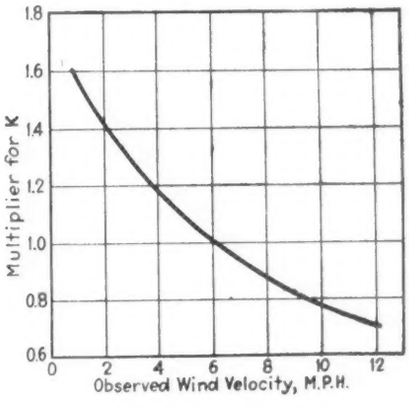


Fig. 4 (Center)—Relative wind velocities at various elevations above open grass land. Calculated from data published in "Annual Wind Summary, 1916" by the Meteorological Office, London, England

Fig. 5—Effect of wind velocity on cooling coefficient K. Find the multiplier for the actual wind velocity under which K was determined. Multiply the observed K by this multiplier to find what the cooling coefficient would have been for a 6-mi. wind velocity, measured 5 ft. above the ground

that if the cooling coefficient were calculated on the basis of water vapor pressure differences rather than on water-temperature differences, the results were more consistent and this method was used. The vapor pressure difference has been found by subtracting the vapor pressure of water at its equilibrium temperature from that of water at a temperature half-way between inlet and outlet water, or mean circulating water temperature. It happens that for the usual range of temperature differences the vapor pressure difference thus calculated is very close to the logarithmic mean vapor pressure difference, which should more logically have been used if cooling were strictly a function of evaporation.

After a time it was found that the water trays gave equilibrium temperatures very nearly 3 deg. below air temperature, and it was therefore decided to use an arbitrary equilibrium temperature 3 deg. below air temperature in all the calculations, partly because actual equilibrium temperatures were not available for several of the lakes studied. Recently some data has been found which indicates that the actual equilibrium temperature of surface water is very nearly the same as air temperature instead of 3 deg. below as found from the water trays. It seems probable that the trays being mounted 4 to 5 ft. above ground were cooled more by wind than would a lake surface, which may account for the discrepancy. The data has, however, not been recalculated, as a great deal of labor is involved, and the final curves of Fig. 3 would not be affected, although the coefficient K in Fig. 2 would be increased, especially at low heat inputs. Low inputs, however, are not of as much interest as those at higher inputs.

There is a feature in Fig. 3 which may appear anomalous, and which is also present but less obvious in Fig. 2. This feature is that if the curves in Fig. 3 are extended to zero heat input they will show a mean lake temperature 5 or 6 deg. higher than air temperature, whereas the actual lake temperature at zero input would, of course, be an equilibrium temperature. This apparent anomaly results from the manner in which the data has been worked up, but does not affect the usefulness of the curves at low heat inputs. Suppose that a lake used for cooling condensing water is infinitely too large for the cooling load imposed on it. The rate of heat input per square foot then approaches zero. For some distance from the condenser discharge the water will be warm but the greatest part of the lake will be at its equilibrium temperature. The temperature rise of water going through the condenser will be normal, say 10 deg., and even though 99% of the lake were at equilibrium temperature the mean lake temperature as used in this study would be 5 deg. above inlet or equilibrium temperature just the same as if only 1% of the lake surface had been cooled to equilibrium. Therefore, the curves in Fig. 3 when approaching zero heat input actually should show a mean lake temperature which exceeds equilibrium temperature by one-half the temperature rise of the water going through the condenser.

The U. S. G. S. Water Supply Paper No. 520[5] states on page 99: "It is quite certain that during July and August the surface water at most places will have a temperature not much below the mean monthly air temperature. On the average, the water temperature will be within 3 deg. above or below the mean monthly air temperature in July, and from 2 to 5 deg. above the mean in August."

Figs. 6 and 7 are copied from U. S. Weather Bureau maps. These are reproduced to indicate what equilibrium temperatures may be expected in various parts of the United States. Those sections of the country which have a restricted rainfall are the ones where a power producer is most likely to be forced to using lakes or towers for cooling purposes, and fortunately, these sections usually have low humidities and high winds, both of which contribute greatly to the effective cooling by both lakes and towers.

Fig. 4 is for use in correcting weather bureau wind velocities, which are usually obtained at appreciable elevations, to the corresponding velocities at a 5 ft. elevation. Fig. 5 shows the effect of varying wind velocity on the cooling coefficient as determined from laboratory experiments. This curve was used in correcting all the observed values of K to the basis of a 6-mi. wind.

The above is an attempt to outline the various factors involved and the manner in which they were taken into consideration in plotting the various curves necessary for estimating the cooling performance of lakes.

A decided advantage of a lake, unless highly loaded, over a spray pond or cooling tower is the freedom from condenser-tube scale deposits with hard waters. The likelihood of scale if a spray pond or cooling tower is used would justify a considerably larger investment in a lake if scale could thereby be avoided, since besides involving shutdowns and cost of removal, the scale reduces the condenser heat transfer coefficient, and thereby the vacuum, both by insulating the tubes and by reducing the amount of water passed through the tubes. In one station where the heat input has averaged about 45 B.t.u. per sq.ft. per hr., no trace of scale has been observed. In another case where the heat input has averaged 60 to 90 B.t.u. at times, a very slight scale deposit has formed. In the first case the hardness of the water is rarely above 250 p.p.m., while in the latter it has been as high as 1,000 p.p.m. and usually above 500 p.p.m., with a total alkalinity of about 150 p.p.m.

Conclusion

It is believed that the present data will permit predicting lake temperatures in the majority of cases within about 5 deg. in the range covered by Fig. 3.

We are indebted to the following for supplying much of the data on which this study is based:

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REFERENCES

(1) "Studies on the phenomena of evaporation of water over lakes and reservoirs," by Frank H. Bigelow, published in Vols. XXXV and XXXVI of the U. S. Weather Bureau "Monthly Weather Review" (1907 and 1908).

(2) "Results of Evaporation Studies Conducted at the Scripps Institution of Oceanography and the California Institute of Technology," by George F. McEwen.

(3) "Public Water Supplies" by Turneaure and Russell, University of Wisconsin.

(4) "Engineering Section Report, 1931-32" of the Southwestern Geographic Division of the former National Electric Light Association.

(5) U. S. G. S. Water Supply Paper No. 520, "Contributions to the Hydrology of the United States."

Fig. 6—Normal Annual Air Temperatures. From U. S. Weather Bureau Map

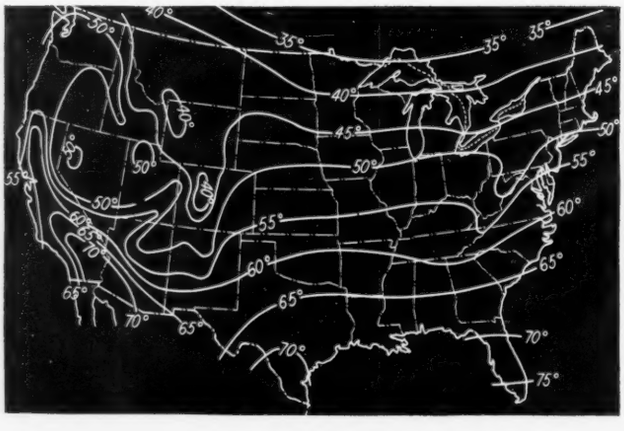

Fig. 7—Normal July Air Temperatures. From U. S. Weather Bureau Map

Dissolved Oxygen and EMBRITTLEMENT*

By W. C. Schroeder[1] and O. C. Ralston[2]

Investigators of caustic embrittlement in boiler metal now agree that silicate as well as caustic soda is a prime factor. This was discussed on page 699 of Mid-December, 1935, *Power*. Here is additional background information

FOR many years it has been assumed that the sole chemical factor of primary importance in the embrittlement of steel was caustic soda. Statistical, operating evidence and experimental investigation seemed to confirm this conclusion. The idea that caustic soda was the only important chemical involved in embrittlement had become so firmly entrenched that when Schroeder and Partridge reported, at the December, 1934, Boiler Feedwater Session of the A.S.M.E., that solutions of pure sodium hydroxide had no appreciable effect upon the ability of steel to carry a uniform tensile load, there was much discussion of the apparent discrepancies between this work and the earlier results obtained by Parr and Straub at the University of Illinois.

The surprising answer to these discrepancies—that silica in solution is a very important factor in the embrittlement of steel—released at the December, 1935, Boiler Feedwater Session of the A.S.M.E., has changed the entire picture concerning embrittlement cracking. This announcement also indicates the pressing necessity for further extensive investigation of the chemical factors contributing to the production and prevention of embrittlement.

The story of how the effect of silica came to be unearthed may be of some interest. It starts with the establishment, early in 1933, of a cooperative investigation between the Joint Research Committee for Boiler Feedwater Studies and the U. S. Bureau of Mines. This work, conducted under the supervision of a subcommittee headed by J. H. Walker, had as its objective the accurate determination of the solubility relations of sodium sulphate in saline solutions such as might be produced by the extreme concentration of boiler water in the capillary spaces in riveted seams. As this study progressed, it became increasingly evident that effective use of the results would depend upon a knowledge of the lowest concentration of sodium hydroxide which would be more effective than water itself in producing embrittlement. In undertaking to answer the latter question, an unexpected difficulty was encountered. It was found that steel could not be caused to fail by embrittlement, even when subjected to uniform tensile loads approaching the ultimate strength at the test temperature. Other investigators, both in this country and in Europe, reported similar results at variance with those obtained by Professor Straub.

Under the guidance of the committee, a search for the cause of these discrepancies was instituted. Exchange of test samples of steel showed that this was not responsible. In discussing the subject, Professor Straub stated that he had used a commercial grade of caustic soda in his tests, and an exchange of some of this material was arranged, since C. P. material had been used in the tests at New Brunswick. Shortly afterwards. Professor Straub verified the fact that the C. P. caustic would not produce failure. It appeared, therefore, that the different results were due to something absent from the pure material and present in the commercial material. A sample of the latter supplied by Professor Straub was analyzed, and the various minor constituents were added in successive tests to the C. P. caustic soda. From these detailed tests, the definite conclusion emerged that silica, present only in very slight amount, was the mysterious agent producing the profound embrittling.

By Oct. 1, 1935, the Bureau of Mines had made a definite progress report to this effect to the committee supervising the investigation. By the time of the A.S.M.E. meeting early in December, Professor Straub had come to substantially the same conclusion, as indicated in the mimeographed paper presented at the Boiler Feedwater Session.

The experimental results obtained at New Brunswick showing the pronounced action of silica, have been described by Schroeder and Berk in the January, 1936, issue of *Metals Technology*. A few of the significant findings may be of interest. The first three results in Table I show how little effect pure sodium hydroxide has on the tensile load which a steel specimen will carry. At the test temperature this specimen had a tensile strength of 82,500 lb. per sq.in., yet a load of 75,000 lb. per sq.in. would not cause failure in 43 days in a concentrated sodium hydroxide solution. Under identical conditions, the addition of a small amount of sodium silicate lowered the load which would produce failure to 60,000 lb. per sq.in.

Tension specimens which are mechanically notched do suffer a reduction in load-carrying ability in chemically pure sodium hydroxide, and a discussion of this effect will be found in *Metals Technology*. On such notched specimens, however, the addition of small amounts of silica lowers the load to cause failure a great deal farther than chemically pure sodium hydroxide. Table II shows the results on eccentrically-grooved tubular specimens. In these solutions the last test shows that the specimen would not carry a load of 20,000 lb. per sq.in. Compared to the indicated tensile strength of the specimen of 71,000 lb. per sq.in. this represents a most serious loss in load-carrying ability.

What does this mean to the boiler operator? Since all boiler waters contain silica, and since no satisfactory method of eliminating this silica is available, it may be argued that the recent discovery does not greatly change the picture. From a different viewpoint, however, the recognition of this effect may give the investigators the first real chance of logically explaining the phenomenon of embrittlement and the opportunity to work out complete and adequate methods for its control. Investigation with this object in view is being made as rapidly as possible.

Table I—Effect of Water, Sodium Hydroxide, and Sodium Hydroxide-Sodium Silicate Solutions on the Tensile Load which a Tubular Steel Specimen will Sustain

Tensile strength of specimen at 250 deg. C. as determined by short-time breaking tests—82,500 lb./sq.in. Temperature 250 deg. C.

Concentrations, Grams per 100 Grams H_2O		Applied Stress, Lb. per Sq.In.	Failure, Days	No Failure, Days
NaOH	Na_2SiO_3			
Water	....	75,000	..	43
25*	....	75,000	..	21
25*	....	75,000	..	43
25	0.4	70,000	2	..
25	0.15	70,000	1¼	..
25	3.0	60,000	5¾	..
25	3.0	60,000	5	..

*C.p. sodium hydroxide which contained 0.02% Na_2SiO_3 giving only 0.005 grams Na_2SiO_3 per 100 grams of water in solution in the bombs.

Data from January, 1936, *Metals Technology*.

Table II—Failure of Eccentrically-Grooved Tubular Specimens in Solutions of Sodium Silicate and Sodium Hydroxide

Tensile strength of specimens at 250 deg. C. as determined by short-time breaking tests—71,000 lb. per sq.in.25 grams NaOH per 100 grams H_2O. Temperature 250 deg. C.

Average Applied Stress, Lb. per Sq.In.(a)	Na_2SiO_3 Grams per 100 Grams H_2O	Failure, Days
40,000	1.6	3
40,000	0.40	2
40,000	0.16	1
35,000	0.16	1¾
30,000	0.16	4
20,000	0.32	3¼

(a) Calculated for area of metal at base of groove.
Data from January, 1936, *Metals Technology*.

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DUAL DIESELS DIG FOR OIL

Two diesels and a motor driving a drilling rig through a dual transmission system combine the best features of former arrangements

By W. C. Lane
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IN DRILLING for oil with diesel-driven rotary rigs, two methods are in use for transmitting the power of the engines to the draw works and pumps. Those driven directly through chains, gears, and/or V belts and clutches are commonly called "mechanical rigs." The name diesel-electric is applied to rigs which involve the use of d.c. or a.c. generators and electric motors. Since about the same number of mechanical drives are used in the two systems it would seem that the former should be the more efficient, for the electrical losses are eliminated. This would be true if it were not for the nature of the loads involved.

The loads on a rig—pumping, rotating the bit and hoisting—differ materially in size and character. Pumping is a constant-speed operation, but at certain stages it is common practice to reduce the speed as much as 40% below normal. Driving the drill stem involves much less power, but it is necessary to vary speed over a wide range as a result of the difference in the character of the formations encountered. The two operations are performed simultaneously so that at least two engines or two motors are required to carry on the work to the best advantage. Attempts made to drive both loads directly from one prime mover are not regarded as successful.

Hoisting is a variable-speed operation in which, on a deep well, the load changes from zero to the maximum capacity of all the engines on a rig within a few seconds. During the hoisting cycle the engines on a mechanical rig are operated at their maximum safe working speed at both an overload and at zero load. At another time the engines will be throttled to as low a speed as it is possible to run an engine on a light load without having it stall. It is necessary to make use of both direct and reverse clutches in controlling operations.

In hoisting with a rig equipped for electrical transmission, the engines are operated at their normal speed and power applied with the clutches engaged. Starting, accelerating the load, stopping and reversing are merely a matter of controlling the voltage supplied to the motor. This is done by altering the magnitude and direction of the current supplied to the separately excited field of the generator. The commercial efficiency of engines operating under such load conditions over a period of years cannot be stated in terms of the fuel consumption alone.

Both types of rigs are in general use in the Mid-Continent area. More of them are to be found in the arid and semi-arid regions where good water is scarce. The actual difference in the fuel consumption of the two types is of no material importance. First cost of the mechanical rig is less than that of an electric rig of the same engine power, hence it is more common. However, there is a marked difference in the flexibility of the speed and torque control of the two systems and in the amount of wear and tear on the engines and drives.

A recent development makes it possible to take advantage of the best features of both systems of transmission. The pumps are driven directly from the engines, and the draw works is powered by an electric motor. When hoisting is to be done, the power of the two engines is transmitted to the motor through a d.c. generator. This eliminates the objectionable practice of varying the speed of the engines and of applying the load with clutches while the engines are in motion. It dispenses with the most troublesome piece of apparatus on a rig—the reverse clutch.

The dual transmission system used on this rig accomplishes another thing. Duplication of engines as a means to increase standby service, interchangeability of engines and of repair parts tends to decrease the efficiency of a rig unless the outputs of the engines are combined and then redistributed. An engine large enough to carry a $7\frac{1}{4}$x18-in. or a $7\frac{3}{4}$x20-in. slush pump, such as are in common use, is loaded very lightly when assigned to a drill-stem load. Any combination that will cause the drill-stem engine to assume a part of the pump load will make it possible to use smaller engines on a given rig.

Power Plant

The arrangement of the power unit is shown in the accompanying sketch, Fig. 1. The two engines are set with their backs facing one another so that their driving shafts may be coupled to the extremities of a short line-shaft. Details of the jackshaft assembly may be seen from the photograph, Fig. 2. Each engine is equipped with an individual clutch, and a third clutch is located in the center of the lineshaft between two V-belt power take-offs. One is used to drive a generator and the other a short jackshaft from which two slush pumps are operated. The driving sheave of the latter is associated with an overrunning jaw clutch so arranged that it may be disconnected from the lineshaft.

The diesels are 275-hp., 9x$10\frac{1}{2}$-in., 8-cyl., 514-r.p.m. units weighing 15,500 lb. each. Each engine and the lineshaft assembly is mounted on steel skids so that they may be loaded on a truck with a minimum expenditure of labor. In setting up the plant, the three assemblies are placed on a common structural steel subbase, no other foundation being required. Water used to cool the engines is circulated through a portable spray tower by means of pumps driven from the engines.

The main generator is rated at 330 kw. 350 volts, 1,200 r.p.m. 40 deg. C., and is driven by a sheave

mounted on a stub shaft. It has the usual three field windings such as are used on shovel-type generators. The exciter is rated at 20 kw., 125 volts, 1,200/800 r.p.m. and is direct connected to the front end of the shaft of the main generator. Its fields are designed so that it may be operated at its rated load and voltage without overheating when speed drops to 800 r.p.m. It lights the rig, drives auxiliary motors and supplies exciting current to the main generator and drawworks motor.

The drilling and hoisting motor is of a totally enclosed type and provisions are made for cooling it artificially in order to keep combustibles and moisture away from the commutator and to make it possible to apply heavy loads to the motor when it is operated at low speeds or is at rest. The motor is rated at 400 hp., 350 volts, 1,000 r.p.m., 50 deg. C. It has sufficient overload capacity to utilize the entire output of the engines. Power is transmitted from the motor to the draw works by means of a geared speed reducer and a chain drive.

Operation of Rig

In the early stages of a well, one engine has ample power to drive both the pump and the drill-stem load. The ratios of the two V-belt drives are such that the pump and generator are driven at their rated speed when the engine is operating at its normal speed. When hoisting work is to be done, the over-running jaw clutch on the pump drive is opened and the entire capacity of the engine is used to drive the generator.

An ammeter near the driller helps him observe the current and watch whether the greatest possible output of the generator is being utilized. If not, he will probably shift the clutches on the draw works to increase rope speed. This direct-reading feature is of great importance, for a driller has many responsibilities while handling pipe and may fail to sense when it is time to change speeds. Time spent in pulling the pipe in order to change a dull bit is lost, and the hoisting operation is performed in a minimum time only when the greatest possible amount of power is used.

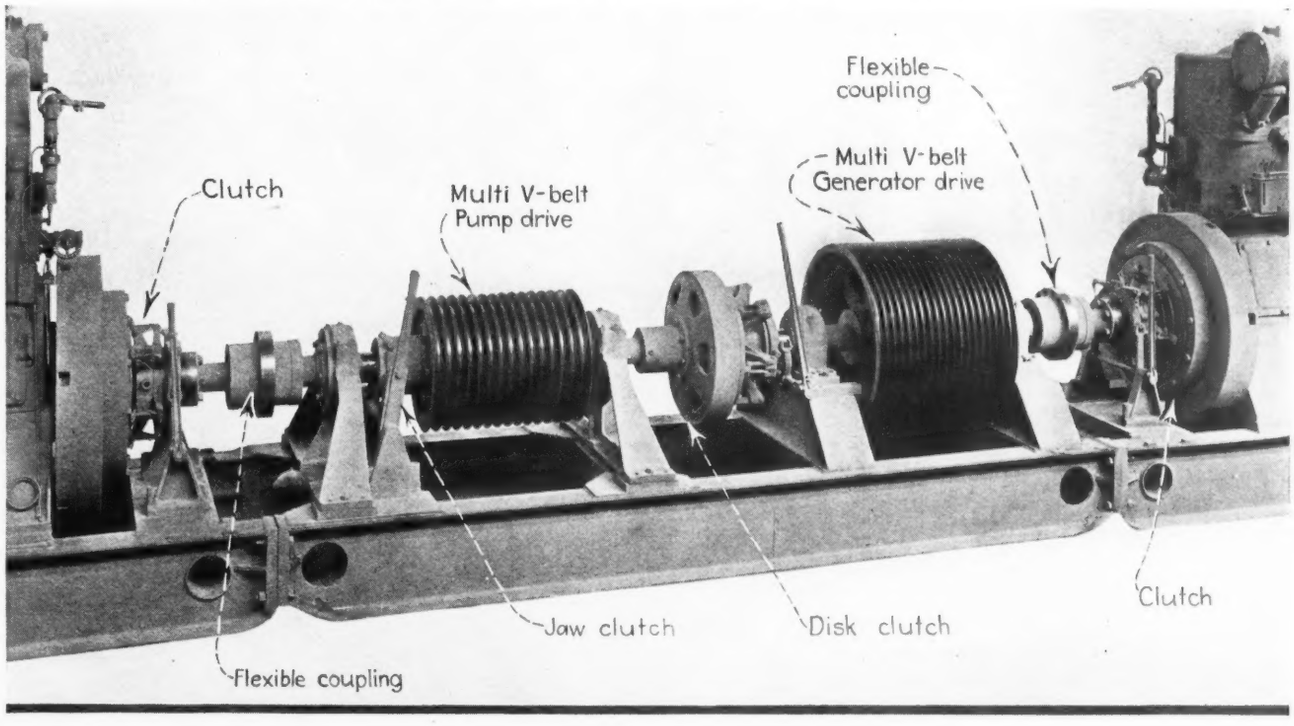
As a greater depth is reached and load increases beyond the capacity of one engine, the second is put in service. The drill-stem load is much less than the capacity of one engine, but since both loads are driven from the common lineshaft, it is divided between the two engines and both are operated at an efficient load. Sometimes conditons arise where it will be advantageous to reduce pump speed. This may be done in two ways—one method is to open the clutch in the lineshaft and drive the pump directly from the engine coupled to the end of the shaft adjacent to the pump power take-off. This is satisfactory if load is within capacity of one engine.

The second method is to reduce the speed of both engines and drive the pump from the common shaft. This will reduce the speed of the main generator and the exciter also and will make it difficult, if not impossible, to control the speed of the draw-works motor, since both its armature voltage and its field will be affected. To forestall this, a regulator is provided for the exciter, which maintains a constant voltage when the speed varies as much as 50% below normal. No difficulty is experienced in controlling the motor so long as its field current and the voltage applied to the separately excited field of the generator remain constant. Incidentally, rig lights and auxiliary motors operate best on a constant voltage.

The driller is required to give no thought to the possibility of overloading the engines, generator or motor, for this is taken care of automatically. The differential field of the generator is so adjusted that when a predetermined load is reached the output of the generator decreases. This limit is determined by the maximum permissible output of the smallest of the triple links in the power chain. In practice this is usually the engines since internal-combustion engines do not have as high an overload capacity as either generators or motors.

Such diesel-driven rigs operate on 6 to 10 barrels of fuel per day and require only a barrel or two of good water. A steam rig of equivalent capacity uses from 75 to 150 barrels of fuel oil per day, and 1,500 barrels of water is frequently evaporated by the boilers in 24 hours.

A drilling-rig drive with two diesels, two couplings, four clutches and two multi V-belt sheaves



WHY BOILER PRESSURES ARE

Internal corrosion, grooving, external corrosion and erosion and corrosion of bracing all play their part in forcing pressure reductions. First of two articles

PRIME among factors governing safe working pressure of a steam boiler is bursting pressure. Although sometimes more or less theoretical, this value can be closely calculated from measurements of the boiler and knowledge of its materials and condition. Dividing bursting pressure by the proper factor of safety gives maximum allowable working pressure.

Any weakness or defect that lowers bursting pressure, or any particular construction for which boiler codes require an increased factor of safety at definite time intervals, necessitates a cut in working pressure. Constructional details affected by boiler codes should be considered at the time the boiler is bought, because once it is installed they cannot be changed. But development of weaknesses and defects in operation are usually controllable by the engineer, hence merit further discussion.

Internal Corrosion

Corrosion or pitting of internal surfaces is probably the most common condition which lowers boiler pressure. Internal corrosion and pitting are closely related, and both result from electro-chemical action between boiler water and metal surfaces in contact with it. Improper chemical composition of water, rate of evaporation, standby service, chemical composition of boiler metal and other causes may accelerate corrosion.

Oxygen in boiler water is the commonest cause of corrosion and pitting. Mechanical deaeration or passing water over exposed scrap-iron surfaces will remove most of it. Deaerators heat the water, causing most of the oxygen to leave with the steam, which passes through a vent condenser from which condensate is returned to the heater while the oxygen passes off. The latter method causes the oxygen to rust the scrap iron instead of attacking the boiler metal, any rust content in the water being removed by coagulation and filtering. F. N. Speller terms this method "deactivation" and describes it in his recent publication on corrosion.

Small quantities of dissolved oxygen may be removed from boiler water by treatment with sodium sulphite, which is frequently used to remove the last traces of oxygen after water leaves a deaerator. The sodium sulphite combines with dissolved oxygen to form sodium sulphate, which is non-corrosive.

Corrosive action may be caused by certain types of scale such as calcium sulphate or magnesium chloride. This condition is best avoided by using softened or evaporated water. Treatment with sodium carbonate (soda ash) often aids by converting the chlorides and sulphates into insoluble carbonates, which are precipitated in the boiler and blown out as sludge.

In smaller boiler plants, use of deaerators, evaporators, water softeners, and similar equipment is usually neither necessary nor practical. Mechanical treatment of internal surfaces is usually most economical and practical.

Before any coating is applied, it is essential that the metal surfaces be thoroughly cleaned. Most of the scale and attached deposits may be removed by boiling out with a solution of about 50 lb. of caustic soda to each 2,000 gal. of water. This process should be effected with a slow fire and the boiler vented to atmosphere. Depending on the condition of the boiler 18 to 24 hr. boiling is usually necessary. After cooling, the boiler should be emptied and washed out.

If the internal surfaces are accessible, or when the corrosion is localized on an accessible area, a cement wash is one of the most effective treatments. The surfaces should be wire-brushed and dry. A solution of cement and water is mixed to the consistency of cream and applied with a brush. While ordinary Portland cement may be used, a hydraulic cement prepared for this purpose is more satisfactory. This coating must be thoroughly dry before filling the boiler with water. Such a coating aids considerably in resisting oxygen corrosion and it has been used successfully in boilers operating up to 250 lb. pressure. Effective lifetime of such a coating depends on the temperature, water conditions, number of times the boiler is taken out of service, and upon the cleanliness of the metal beneath the coating. It usually lasts about 2 yr., then surfaces may be cleaned and recoated.

A protective coating may be formed on clean surfaces that are inaccessible for cement coating, by feeding either dissolved lime or silicate of soda (water glass) into the boiler. About 3 lb. of either solution should be used for each 1,000 gal. of boiler capacity at normal water level. This treatment is not continuous, and the stated amounts should be added at intervals, found by trial, to maintain a light, protective coating. The silicate coating is sometimes more or less transparent, and care should be taken not to build up a heavy layer which would result in considerable loss of heat transfer and possibly cause burning of the boiler.

Special paints have been developed for protecting boiler surfaces, and they provide excellent protection if they are applied to clean surfaces.

Grooving

Another type of internal corrosion in boilers is known as grooving. This usually occurs in sections of the boiler plate under constant expansion and contraction stresses, known to many engineers as "breathing action." The more common places attacked by grooving are on furnace sheets, just above the mud-ring, in vertical fire-tube and locomotive-type boilers. Other places affected include sections of boiler plate along the lapped edge of plates and straps at riveted seams.

Grooving often causes a serious reduction in plate thickness. Although corrective boiler-water treatment usually retards or prevents further action, there are many installations where "breathing action" continues to dete-

CUT—I

By Harry M. Spring

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riorate the plate. Care should be taken to operate as nearly as possible to constant pressure and temperature.

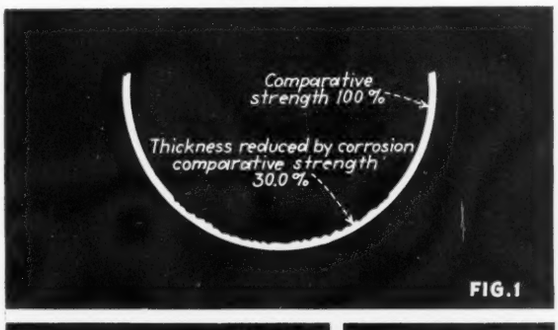
When grooving of a furnace sheet in an internally fired boiler has extended to such depth that repairs are necessary, the exact location of the groove should be marked on the fire side of the sheet. The plate is then chipped or burned through along the defective area. The edges should be veed off and arc-welded together. This repair should be made only where the furnace sheet is staybolted to the wrapper sheet. With other types of furnaces and with shell plates grooved at riveted seams, the proper repair necessitates cutting out the defective section and riveting on a patch.

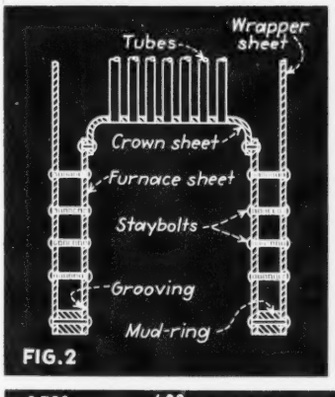
Braces such as the staybolts of locomotive and other internally fired boilers, usually corrode at or below the water line. Diagonal and head-to-head stays in horizontal-tubular boilers and radial stays in locomotives are also affected by corrosive action that may seriously weaken the boiler by reducing the cross-sectional area of the braces. The allowable working pressure is then reduced accordingly. This corrosion is caused by essentially the same action attacking other parts of a boiler. Corrective treatment as previously described should be followed.

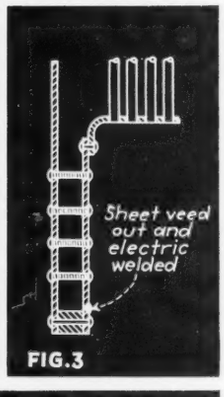
External corrosion is caused and dealt with in an entirely different manner than internal corrosion, but its ultimate weakening effect is much the same. External corrosion is caused, primarily, by soot or ash accumulations in contact with the boiler surfaces in the presence of moisture. This deposit often contains a certain amount of sulphur, which combines with water to form a sulphurous acid, causing a rapid corrosive action that may seriously deteriorate a shell or head.

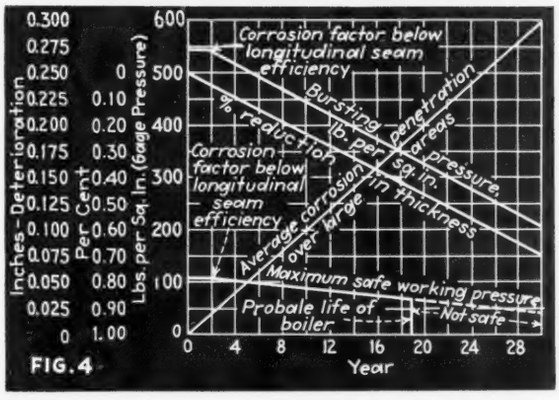
Preventive procedure should stress three points; accessibility of susceptible parts, frequent cleaning, and keeping external surfaces dry. Blind heads of Stirling-type boilers are often difficult to clean or inspect due to close proximity of the brick sidewalls. At such points the brick should be chipped back at least 3 in. to facilitate cleaning and inspection. Leaky handhole gaskets, tube ends, and pipe fittings are a common source of rapid, external corrosion. Sweating of an idle boiler often causes similar trouble. Proper maintenance will take care of the leaks, and keeping an idle boiler ventilated by a slight draft through furnace and gas passages will aid in preventing sweating. Frequent cleaning of gas passages and heating surfaces is part of an intelligent plant-maintenance program.

Fig. 1—Cross-section of boiler drum or shell, showing effect of corrosion on wall thickness. Fig. 2—Grooving in vertical fire tube boiler and, Fig. 3—How grooving can be corrected. Fig. 4—Typical example of weakening effect of corrosion on 72-in. diam. boiler shell. Longitudinal seam off. 82.1% average corrosion penetration, 0.010 in. per year (untreated water, high in magnesium chloride, oxygen and mine drainage products)









Erosion

Closely allied with external corrosion in effect is external erosion, resulting in a reduction in thickness of the boiler plate. It is caused by the abrasive action of high-velocity soot and fly-ash, against shell, heads, and tubes. Although this action is slow, it is progressive. Tubes removed from boilers after 10 to 20 yr. of service often show a marked reduction in thickness, yet little or no trace of internal or external corrosion. This action is, however, controllable only by the surface hardness of the metal, and by the design of the boiler installation in so far as it affects gas velocities and draft.

Erosion of boiler surfaces is often localized by action of steam or air soot blowers. Jets should not come in close contact with any part of the boiler, as they have a severe erosive action similar to sandblasting. For example, in one plant five tubes of a water-tube boiler had to be renewed at the end of 4 yr. because a soot-blower element had slipped in a longitudinal direction, allowing the steam jets to strike against the tubes instead of blowing between them. This is a condition that often occurs and should be periodically checked.

Flame impingement is another source of rapid erosive action. This condition is more prevalent with pulverized coal where an improperly adjusted burner or the wrong secondary air adjustment may cause direct flame impingement on water-wall, slag-screen, or generating tubes. Such localization of heat may also cause serious trouble with bulging or even bursting tubes.

UNIT AIR CONDITIONERS AND

Previous articles on simplified air conditioning have dealt with central systems. This one discusses the application of units

DURING the early days of air conditioning, equipment available consisted of air washers, fans, refrigerating plants and controls, all assembled at some central point. Conditioned air was delivered to the point of use through ducts. Central air-conditioning systems are still used for most of the large installations such as occur in theaters, auditoriums, hotels, office buildings, and factories, particularly when air conditioning is provided for in the original design.

To meet the needs of smaller installations and modernization of old buildings, a great variety of unit conditioners have been developed. Some of these contain all of the equipment used in a central system, but assembled under a single housing and performing the same function. Others do not and therefore do not provide completely controlled air conditioning. Hence the engineer is not only confronted with the necessity of deciding whether to use central or unit air conditioning but also whether the particular circumstances require all-year-round conditioning envolving controlled cooling and dehumidification for summer, heating and humidification for winter, filtration and air movement.

Unit air conditioners are available for installation in industrial plants and for comfort use where the unit is placed in the space to be conditioned (such as in offices, restaurants and small stores). The latter type are provided with a cabinet of pleasing design and finish and generally do not provide more than about 1,500 c.f.m. of conditioned air. Consequently they are applicable to relatively small spaces whose requirements can be satisfied by convenient installation of one or more units. Industrial types for factory use or for comfort purposes where the unit will be installed in a space separated from the room to be conditioned are usually of larger capacity —up to about 10,000 to 15,000 c.f.m. Heating and cooling capacity of these units varies considerably, depending upon the condition of the air passing through them. Industrial types remove up to about 500,000 B.t.u. per hr. and the comfort type up to about 55,000 B.t.u. per hr. Cooling capacities are usually given in B.t.u. per hr. for entering air at 85 deg. and 50% relative humidity with refrigerant at 40 deg. Total cooling capacity is sometimes divided into sensible heat-cooling effect and dehumidification effect.

Unit conditioners are particularly applicable to the modernization of existing buildings, because they can be installed without having to run supply and exhaust ducts, a difficult job when expensive interior decorations have to be considered. With unit conditioners, only power and piping connections have to be provided. Individual offices in a large building, small restaurants and stores are a fertile field for the unit comfort conditioner.

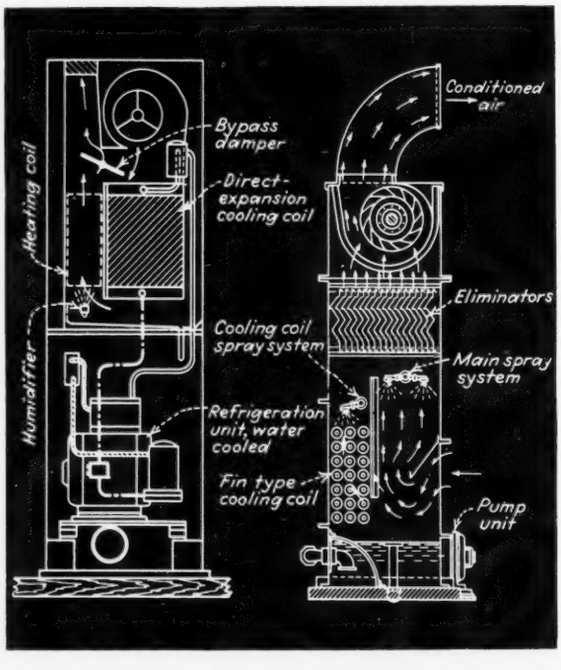
Sometimes in buildings provided with a central conditioning system, there may be spaces with different temperatures and humidity requirements or with peak heat-removal loads that occur at other times than the peak on the rest of the space furnished with conditioned air from the central system. In such circumstances, installation of unit conditioners may be found to be more economical and to give more satisfactory results than attempting to meet these special load requirements from the central system.

Unit conditioners of the type used in the occupied space usually have dry-fin type cooling coils, heating coils, a fan, air filter and a drip pan to catch condensation from the cooling coils. Some units also have pans provided with water under float control and having sufficient evaporative surface to provide humidification during the heating season. Other types employ sprays for this purpose.

The cooling coils may be supplied with cold water, brine or direct expansion of a refrigerant from a refrigerating unit in a separate room or in the unit as in Fig. 1. One such unit uses the water condensed out of the air to assist in condensing the refrigerant. This has the added advantage of eliminating the necessity of a drain connection. When direct expansion of a refrigerant is used, its temperature is usually maintained at about 40 deg. Chilled water or brine are usually maintained at temperatures two or three degrees higher.

When dry cooling coils are used, it is difficult to control humidity, and in many units no control is provided. Air usually leaves such coils with a wet-bulb temperature some 3 to 4 deg. below the dry-bulb. Some units, such as that in Fig. 1, effect some control of humidity by con-

Fig. 1 (Left)—Refrigerating plant included in air conditioner. Fig. 2—Industrial air conditioner with air washer



COOLERS

By R. B. Purdy
Associate Editor

trolling dampers which cause part of the air to bypass the cooling coils.

When conditioning units are in the space to be conditioned, they are usually placed in front of windows and discharge the conditioned air vertically with a slight pitch toward the room at a velocity of 1,000 to 1,200 ft. per min. This velocity carries the entering air to the ceiling and entrains room air with it. For this reason, and during hot weather, entering air may be as much as 20 deg. below room temperature.

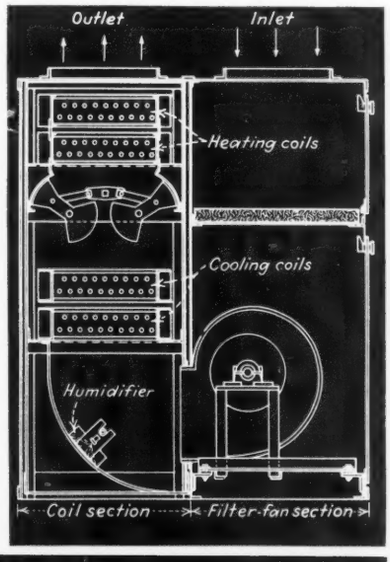
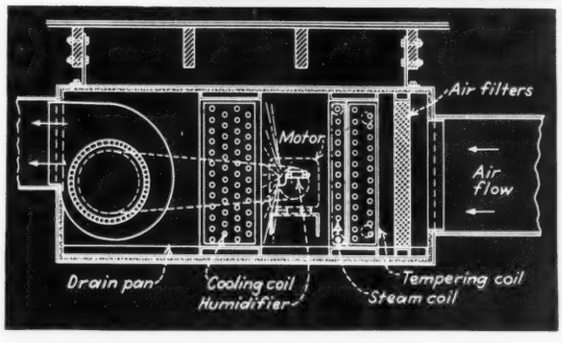


Fig. 3 — Winter hot-air temperature controlled with bypass dampers

Fig. 4—Suspended type air conditioner



Return-air inlets are sometimes in the front near the floor, in which case a person sitting near the unit may experience some discomfort from draft. Side inlets overcome this to a large extent, and one manufacturer even places the return inlet in the top and behind the air outlet. Some units are provided with fresh-air inlets in the back and dampers for controlling the amount of fresh and recirculated air.

Quiet operation is particularly important when the unit is placed in an occupied room. This calls for careful fan design and selection by manufacturer and noise insulation for the motor and fan bases.

Industrial-type conditioners, such as that in Fig. 2, provide complete control of air conditioning with the same accuracy obtainable with central systems. They are provided with cooling coils, air-washer sprays, spray-water circulating pump, reheating coils, fan, filter and control.

In the unit shown, the cooling coils may be supplied either with a refrigerant or with cooled brine or water from an outside source. Recirculated spray water is cooled by spraying it over the cooling coils. Water temperature is controlled by varying the amount of water sprayed over the cooling coils. Eliminators are, of course, provided to prevent air from carrying out entrained moisture, and the fin-type heating coil may be placed after the eliminators to permit reheating.

Manual control is used to a large extent with the smaller unit conditioners because of the high cost of automatic control. With the large units, a simple automatic control is, however, provided by many manufacturers. It consists of a thermostat which controls the operation of the fan motor, or, as in one case, it operates a volume-control device on the fan. Units such as in Fig. 1 are controlled by operation of the bypass damper. Controls for units such as Fig. 2 are more complete and function much like the controls of a central conditioning plant.

Cooling Units

When cooling, uncontrolled dehumidification and air movement only are required, cooling units similar to unit heaters may be employed. These are usually suspended from the ceiling. The finned coils may be arranged for direct use of an expanding refrigerant or for cooled water or brine. A drip pan and drain is provided to catch the condensation forming on the cooling coils, and the case surrounding the unit is insulated from the coil so that condensation will not take place on it. A propeller-type fan provides for air movement through the coil, and louvers on the discharge direct the air horizontally so as not to cause uncomfortable drafts. A filter is often provided on the inlet side to prevent the coil from becoming choked with lint and dirt. It should be recognized that such unit coolers do not provide air conditioning in the strict sense of the word.

Some unit conditioners are arranged so that their refrigerating plants may be used for a limited amount of heating by the reversed-refrigeration principle. This requires that the function of the cooling coil and the refrigerant condenser be interchanged so that air delivered to the room absorbs heat from the condensing refrigerant. This heat comes from the heat absorbed from the outside air surrounding the coils in which the refrigerant is made to expand. Heat delivered by reversed refrigeration is between 2.5 to 3.5 times the heat equivalent of the electric energy taken by the compressor motor. This arrangement is of value in mild climates or during early spring and fall in more severe locations.

Most unit conditioners are arranged for floor mounting, particularly those units intended for use in the space being conditioned. Occasionally suspended mounting is more convenient, as on the unit of Fig. 4.

A.S.H.V.E. CONSIDERS ROOM—AIR NEEDS

HEATING and air-conditioning engineers gathered at the Palmer House, Chicago, Jan. 27-30, to attend the 42nd Annual Meeting of the American Society of Heating & Ventilating Engineers and to visit the Fourth International Heating & Ventilating Exposition. The National Warm Air Heating & Air Conditioning Assn. also held its 23rd Annual Convention during this week, and one of its meetings was held jointly with the Heating & Ventilating Engineers.

Most of the papers presented dealt with air-conditioning problems, a notable exception being a paper on corrosion in steam-heating systems by R. R. Seeber, F. A. Rohrman and G. E. Smedberg. This reports the results of tests at Michigan College of Mining Technology to determine the effect of pressure, oxygen, CO_2 and temperature on corrosion rate, to correlate the rate of corrosion as measured by the N.D.H.A. tester to the actual life of the pipe and to develop an electric-resistance method of determining corrosion rate.

Work done indicates that practically zero corrosion takes place in the supply side of radiators, consequently the following conclusions have to do with corrosion on the return side. Decrease of pressure, quality of steam being the same, decreases corrosion rate in a tight system. In an open system, corrosion rate increases with temperature up to 115 to 120 deg., then decreases. Other factors being constant, corrosion rate varies directly with oxygen and free CO_2 content of the condensate. One p.p.m. of oxygen has about the same corrosive effect as 20-30 p.p.m. of CO_2. Comparison of results obtained with N.D.H.A. tester with actual pipe indicates that 84 units on the tester compare with 100 units in actual pipe. A tester adapted to an electric-resistance method of determining penetration is described in the paper for which greater sensitivity is claimed, and measurements can be made without disturbing the set-up.

Ventilation Requirements

A PROGRESS report of research at Harvard University sponsored by A.S.H.V.E. from which it is expected sufficient data will eventually be obtained to permit fixing ventilation requirements, was presented in a paper by C. P. Yaglou, E. C. Riley and D. I. Coggins.

The report describes tests made to determine factors influencing odors produced by occupants in ventilated rooms and among the conclusions gives the following:

Healthy, clean persons freshly after a bath gave off an appreciable amount of odor which required from 15 to 18 c.f.m. of outdoor air per person to dilute it to a concentration that was not objectionable to persons entering the room from relatively clean air. A week after a bath, the ventilation requirement of children increased from 18 to 29 c.f.m., as compared with an increase of from 15 to 20 in the case of adults.

The usual processes of washing, humidifying, cooling and dehumidifying recirculated air apparently removed a considerable amount of body odor and, under certain conditions, practically the maximum amount possible by the use of known processes.

Concentration of CO_2 in the air of occupied rooms proved to be an unreliable index of ventilation, from the standpoint of both outdoor air supply and odor intensity.

The paper on "Comfort Standards for Summer Air Conditioning" is based on work done at the Society's research laboratory in Pittsburgh, designed particularly to investigate shock experienced upon entering an air-conditioned space from hot outdoor conditions, and whether it is necessary to maintain constant indoor dewpoint as indicated in the recommendations in the *Guide*.

The work done indicated that air conditions ranging from 70 to 71 deg. to 74 or 75 deg. effective temperature give a feeling of comfort over a wide range of moisture content regardless of outside temperature. Within this range no appreciable variation was observed in the cooling shock with either relative humidity of the cooled condition or severity of the previous condition. As a result no limitation need be placed on relative humidities between 30 and 60%. After the cooling shock, recovery to a feeling of comfort usually was experienced within 20 min.

Performance of Fin-Tube Units

G. L. TUVE reported the results of 250 1-hr. tests on fin-tube air heaters and coolers at Case School of Applied Science. These indicate that reasonably accurate performance tables may be built on the basis of a few simple straight-line graphs (on logarithmic coordinates) of over-all heat-transfer coefficients plotted against air velocity. For rapid approximate calculations, capacity of a heating or a dry-cooling fin coil may be assumed to vary directly as the square root of the air velocity.

Over-all heat-transfer coefficients for 500-f.p.m. velocity were found to vary from 16 B.t.u. per hr. per deg. temp. difference per sq.ft. of inside surface area when air cooling and dehumidifying with direct expansion to 4.7 when cooling without dehumidifying, and from 13 to 6.5 B.t.u. per hour for heating with steam.

Among some of the methods suggested for increasing the over-all coefficient were listed: Placing a turbulence grid in front of the first row of tubes, increasing velocity of the liquid in the tubes, using staggered tube arrangement, and corrugating the fins.

Officers elected for 1936 are G. L. Larson, president; D. S. Boyden, first vice-president; E. H. Gurney, second vice-president; A. J. Offner, treasurer. Members of Council elected for 3-yr. term are R. C. Bolsinger, S. H. Downs, W. L. Fleisher, C. M. Humphreys. At the banquet held Wednesday evening, Dr. A. C. Willard received the F. Paul Anderson gold medal for his work in heating, ventilating and air conditioning.

Exposition

The International Heating & Ventilating Exposition, with exhibits of over 300 manufacturers, occupied almost the entire second floor of the new Chicago Amphitheater. In the opinion of many visitors, this was the best exposition of recent years. One reason was the lack of miscellaneous exhibits, all of them being definitely in the heating, ventilating and air-conditioning field.

Equipment for large building and industrial service included many types of fin-tube heaters and coolers, fans, humidifiers, refrigeration equipment, pumps, unit air conditioners, and controls in profusion.

A heating-system control based on a new principle employs a heat flowmeter which sets up an electric current proportional to heat flow from the building. A somewhat similar instrument is placed on a control radiator and sets up an electric current proportional to the output of the radiator. When these two currents are balanced, the call for steam to heat the building is satisfied. If, however, the current from the heat flowmeter is greater than from the control radiator, the control acts through an on-and-off system to increase steam flow.

Operation of another well-known heating system control was explained at regular intervals by synchronized signs and electrical transcription using loud speakers.

A new radiator orifice gives a straight-line relation between pressure and steam flow instead of the usual curve.

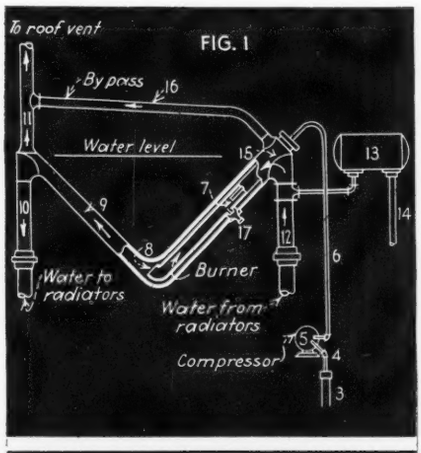
One of the difficulties of controlling fin-tube preheaters and reheaters with modulating valves is that at part loads only a portion of the surface is heated, and air passing through the coils is not heated uniformly. A fin-tube coil arranged with distributing pipe internal to the tubes which causes the coil to heat uniformly through its length when steam supply is throttled was effectively displayed, showing by comparison operation with and without steam distribution.

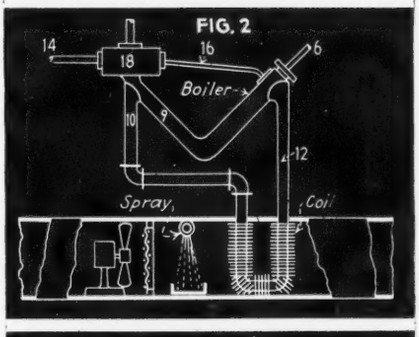
A new arrangement of vacuum pump was displayed with pumping units placed vertically. Boiler-feed and circulating pumps are driven by separator motors.

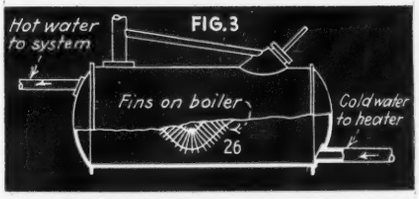
Among the myriad of controls shown was a Windostat designed to control relative humidity so as to prevent window condensation during cold weather. Another combination thermostat controls air conditions according to effective temperature. One instrument indicates air velocity directly on a scale much like an indicating voltmeter. Accessory equipment is provided for making velocity traverses of grilles or ducts.

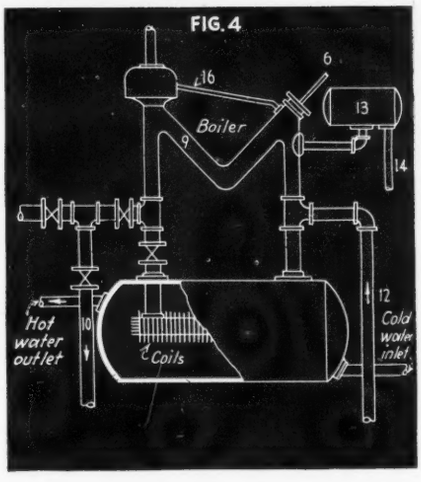
IT'S A BOILER!

Fig. 1—The boiler is nothing but a pipe with a burner inside. Gas-air mixture burns under water. Efficiency claimed is 90%. Fig 2—Boiler in series with indirect radiation. Fig. 3—Boiler and finned surface submerged in tank for heating service water or process water. Fig. 4—Boiler in series with finned surface in hot-water heater. Avoids contamination of water by gas









SHAPED like a banana, a boomerang, or a sawed-off hockey stick—and not much larger—the gadget shown at the head of this page is actually a complete boiler, big enough to heat an average-size dwelling. Unprecedented compactness makes it possible to stick this "boiler" in the attic or a closet, or hang it from the ceiling in some corner.

The excuse for presenting this rather sensational "domestic" device to the readers of *Power* is that it embodies principles which may soon find an application outside the domestic field, particularly in building heating or in heat supply for plant processes.

The following account has been prepared by *Power* from U. S. Patent No. 2,625, 695 (Dec. 24, 1935), made by Richard M. Stewart of Montclair, N. J., and assigned to the Ellis-Foster Co. The description and claims here presented are merely briefed from those in the patent, and should not be assumed to represent *Power's* own opinion of the practicability of this interesting invention.

With this preamble, let's see what this gadget is and how it works. The boiler (a gas-burning, submerged-combustion unit) is shown in its primary application to a hot-water heating system in a house of moderate size. It is placed in the attic to insure a very small hydrostatic head on the burner, important because the burner is supplied with a compressed mixture of illuminating gas and air. Low hydrostatic head means low compression. Circulation through the heating system is obtained not by the usual thermosyphon effect, but by the ejector action of the burner.

Operation, in brief, is as follows (Fig. 1): Illuminating gas and air, in proper proportion, enter through needle valves 1 and 2, intermingle in 3 and are compressed in 5 to slightly above atmospheric.

Pipe 6 leads the compressed mixture to nozzle 7, where it is discharged into the burner at a velocity greater than the rate of backfire. The burner casing is lined with some heat-resisting substance, refractory or metallic. Combustion takes place completely throughout the length of the burner tube, and hot products of combustion are discharged directly into the water of the heating system through the burner mouth 8, covered with a perforated plate to produce gas bubbles and intimate mixing in the region of heat transfer (9) and exhaust pipe (11).

At the indicated water level, the gases separate from the liquid, the water passing down through header 10 to the heating system. Water, returning to the heater from the radiators by header 12, flows through the annualar space in the heating unit between the burner and the casing. Any gas trapped in the upper part of the annular space passes out through the bypass 16. The level of the liquid within the boiler is kept at the correct point by tank 13, equipped with float-valved supply through 14. One means of igniting the burner is a spark from contact 17 to orifice 7.

Among the numerous advantages claimed for this equipment, the outstanding are extreme simplicity, small size, cheapness, 90% efficiency (experiments have shown thermal efficiencies of 95%, over-all efficiencies above 90%). The chimney, for an ordinary house, is merely a small malleable iron pipe. As the equipment is entirely sealed, no gas or fumes can escape within the structure. A thermostat may be applied to make operation automatic.

Because of its small size, the equipment may be made of corrosion-resisting material at low cost. Radiators and pipe are of the conventional type. Heat inertia of the system is small and circulation starts as soon as the boiler goes into operation.

Other claims in the patent indicate how this equipment might possibly be applied in buildings and industrials. For hot-air heating, the boiler may be placed in series with a finned heater in an air duct alongside, air being forced over the heater by a fan. To heat water or any other liquid without contact with gas, the fin heater, in series with the boiler, may be immersed within the tank. In fact, the boiler itself, equipped with fins, may be so immersed, Fig. 3.

Metropolitan Water District Buys Country's Largest Pumps

METROPOLITAN Water District, Los Angeles, Calif., has awarded three contracts for pumping units to handle 390,000,000 gal. of water daily from Parker Dam to the city. Worthington Pump & Machinery Corp., Harrison, N. J., was awarded six 12,000-hp. centrifugal pumping units for capacity of 130,000,000 g.p.d. each against 460 ft. total head, to be installed in groups of three at Hayfield and Eagle Mountain Plants. Byron Jackson Co., Berkeley, Calif., was awarded six 8,000-hp. units for 320-ft. total head, to be used for the initial lift and at Gene Wash Plant. Three 5,000-hp. units for 160-ft. lift were awarded to Allis-Chalmers Mfg. Co., Milwaukee, Wis., to go in Iron Mountain plant.

Parker Dam itself is 155 mi. below Boulder Dam. The initial lift at the river will raise water 290 ft. from reservoir elevation 450 to the 5,640-ft. Colorado Tunnel, thence at elevation 735 into Gene Wash Reservoir. The second plant lifts water 301 ft. to elevation 1,036 and discharges it in Copper Basin Tunnels Nos. 1 and 2 (aggregate length 12,280 ft.) and Copper Basin Reservoir between Tunnel No. 2 and the 32,190-ft. Whipple Mountain Tunnel. After it leaves this tunnel, the water passes 65 miles through siphons and open canal to Iron Mountain Pump Lift, where it is raised 147 ft. from elevation 900 and delivered to the 39,805-ft. Iron Mountain Tunnel. From the end of this tunnel it passes by canal and pressure line 40 mi. (including the 17,530-ft. Coxcomb Tunnel) to Eagle Mountain, where it is lifted from elevation 966 to 1,404 and delivered to the East and West Eagle Mountain Tunnels. These total 35,778 ft. and are separated by about 2 mi. of canal. A 10-mi. canal leads next to Hayfield Reservoir. Here the final and highest lift (440 ft.) is made to Hayfield No. 1 Tunnel at elevation 1,807. Then follows about 24 mi. through six tunnels and canals to the 18-mi. East Coachella Tunnel. 11 tunnels, varying in length from 790 ft. to 3.2 mi. and two major siphons carry the water on to the San Jacinto Range, penetrated by the 13-mi. San Jacinto Tunnel. In the 20 mi. beyond this tunnel are two more, the 6,220-ft. Bernasconi and the 37,150-ft. Valverde, leading finally to Cajalco Reservoir at elevation 1,405.

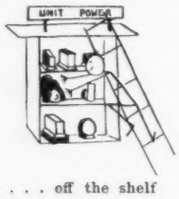
SPEAKING OF POWER

● I am writing this page in New York shortly before embarking for Germany (Feb. 20). When it appears in the March number, I shall be hard at work in Leipzig. . . . The nine days I have scheduled for coverage of the machinery exhibits at the great Leipzig Fair will be none too many. In all there will be about 8,000 exhibits, of which 2,000 will be along engineering lines. The Fair is devoted entirely to practical matters; there are no amusement or educational features. All buildings are permanent—34 in the city and 18 great exhibition halls at the fairgrounds. . . .

2,000 exhibits . .

In talking with some of the building engineers around New York, I find the "degree day" method of figuring heating performance is taking hold. It's the most practical way to allow for the variations in the weather and the amount of space to be heated . . . In case you are not familiar with this unit, here's the whole story in a nutshell: On any day where the average temperature is below 65, call the deficit the degree days for that day (e.i., if average temperature is 55, degree days are 10). Add the degree days for the individual days to get the degree days for the month or other period used. Divide the fuel or steam used for heating in this period by the degree days of the period. Divide this quotient by the cubic feet of heated space. Then you have a figure you can compare with other months or seasons and with other structures of the same type in other cities. . . . Try it on February figures.

In diesels, the trend is strongly toward self-contained units, complete little power plants on a steel frame. You can now buy "off the shelf" a unit consisting of engine, closed cooling system with radiator, air filter, lube-oil filter, fuel-oil strainer or filter, generator, flexible coupling, instrument panel (centralized with control), starting devices. . . . Better than a third of sales last year were of these units.



. . . off the shelf

This "off-the-shelf" trend, by the way, is not confined to diesel units, although most pronounced there. In the boiler field we see the trend toward standardized steam-generating units in the smaller sizes. For many years the Germans have been building small "locomobiles," stationary power plants with the engine mounted directly on top of the boiler. If I remember rightly, the cylinder is jacketed with flue gases to keep it hot.

May I suggest that you keep an eye out for the 20-page air-conditioning section in April. Then for June, a section of at least 20 pages on prime movers: steam engines, steam turbines, diesel engines, gas engines, hydro turbines. . . . In the present number, on page 135, you will find a short section on Water Walls and Arches, a supplement to the section which appeared in the September, 1935, number.

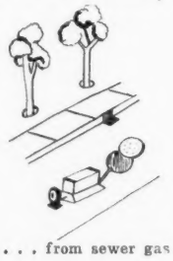
I may be criticized for running the story of the strange contraption pictured on page 153. In the first case it is a house-heating boiler and *Power* is not a home-engineering magazine. Secondly, the equipment described is hardly beyond the patent stage. Thirdly, this boiler is a phoney-looking bird, about the size and shape of a man's arm crooked at the elbow. . . . My excuse is that the device, while still untried, appears to combine extreme cheapness and compactness with high efficiency. Moreover, it is revolutionary in its application of submerged combustion to house heating. Early publication of the story for what it is worth will stimulate inventive minds in the power field to study the idea and consider possible applications in buildings and factories. In a radical departure of this sort, one naturally looks for bugs, and I expect that they may be found in the shape of corrosion. . . . Which reminds me that the power engineer needs a new saint, one who will chase all the bugs out of the power plant, just as St. Patrick chased all the snakes out of Ireland. A good idea, but present indications are that each engineer will have to hang on to his own halo.

It's a boiler . . .

. . . bugs begone!

Professor Christie writes me about the lectures on engineering practice which Johns Hopkins University is offering to the engineering public of the Baltimore region. The seven lectures this year, all dealing in a practical way with the properties of metals and alloys, will be given during March and April by members of the staff of mechanical engineering. Engineers, plant managers, foremen and mechanics are particularly invited. . . . This idea of making the university a font of practical education for the community is growing.

Because of their education and experience, many *Power* readers, particularly those in the smaller communities, are asked to advise their municipal authorities on certain engineering matters. There is plenty of need for the mechanical mind, for not all community engineering is civil engineering, by a long shot. . . . Take sewage disposal, for example. While mainly civil engineering, it may also involve both pumping and power generation. I suggest that you read the article on page 120 and bring it to the attention of your local authorities concerned with sewage disposal.

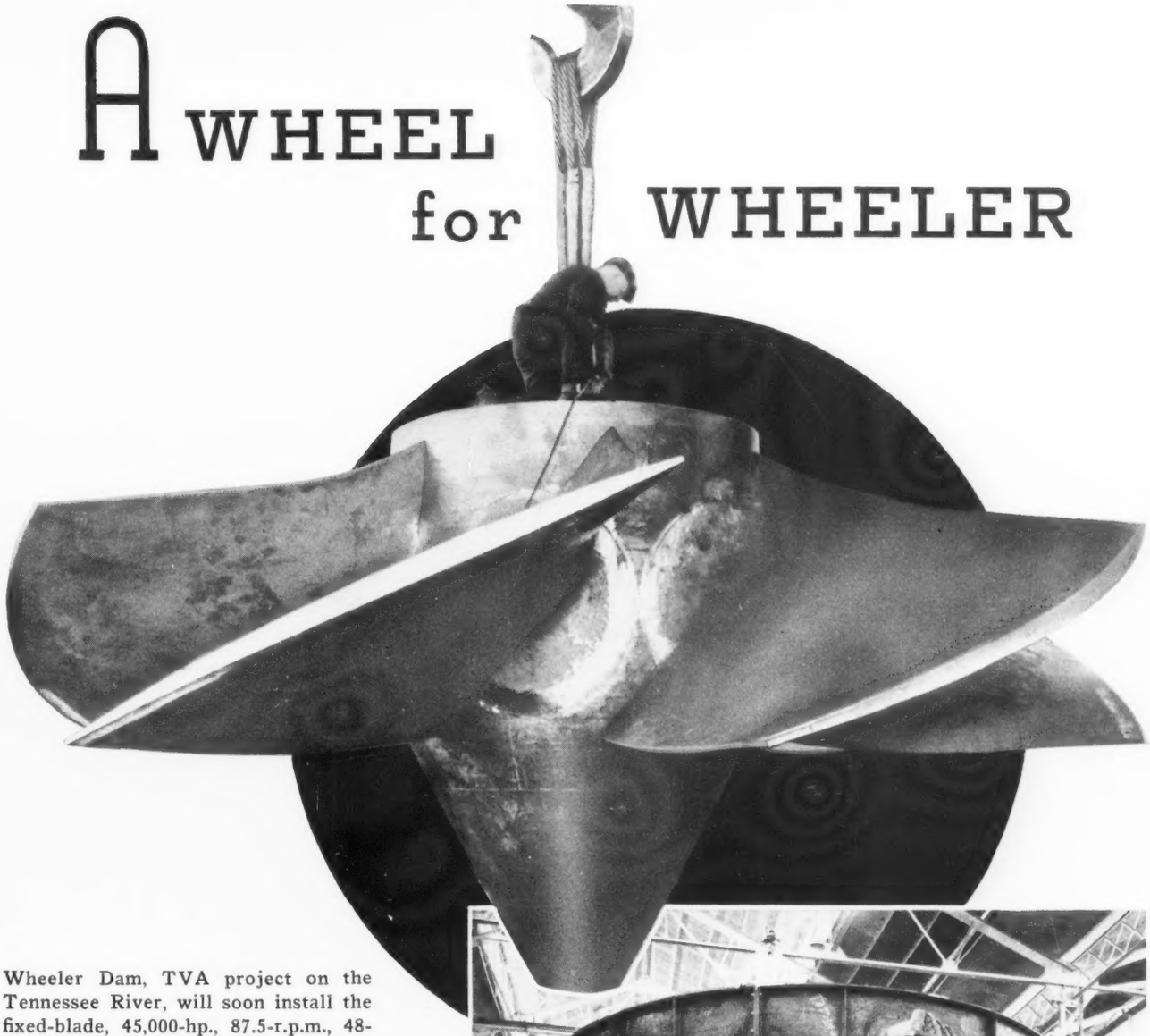


. . . from sewer gas

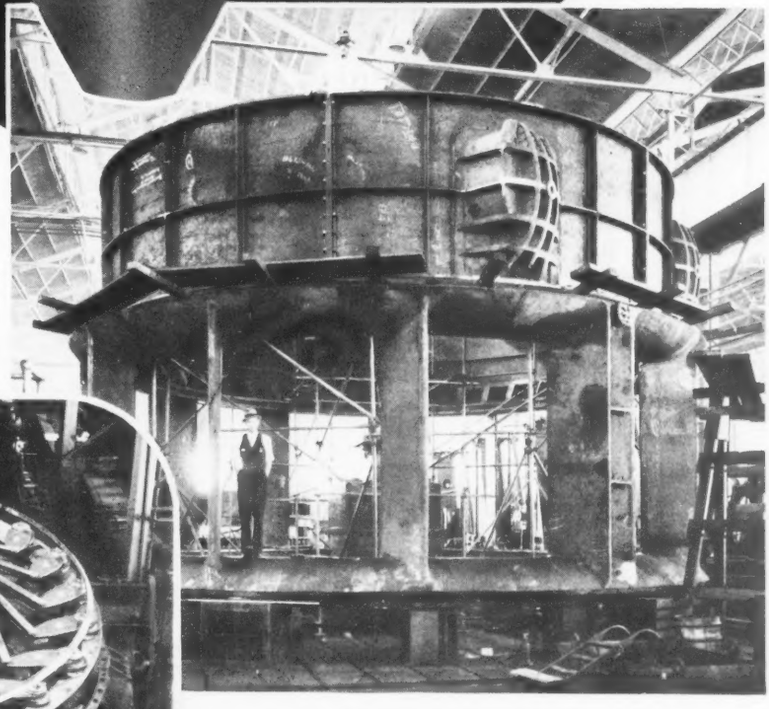
Many operators of condensing plants where nature provides no large lake, river or ocean, will be interested to learn on page 142 how much cooling they can get from natural evaporation of a pond.

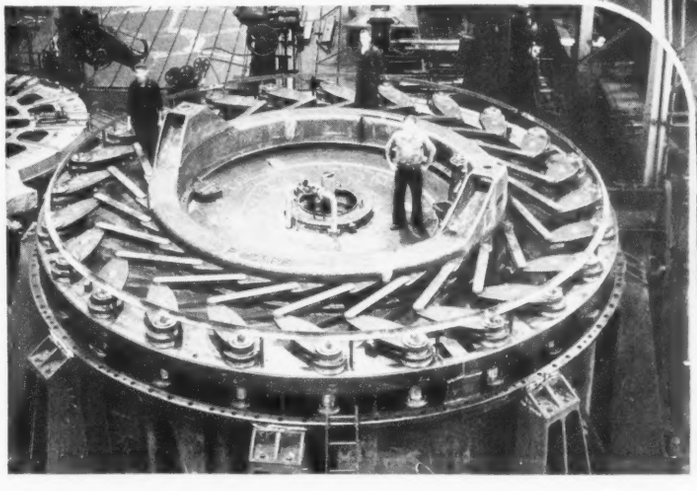
PHIL SWAIN
Editor

A WHEEL for WHEELER



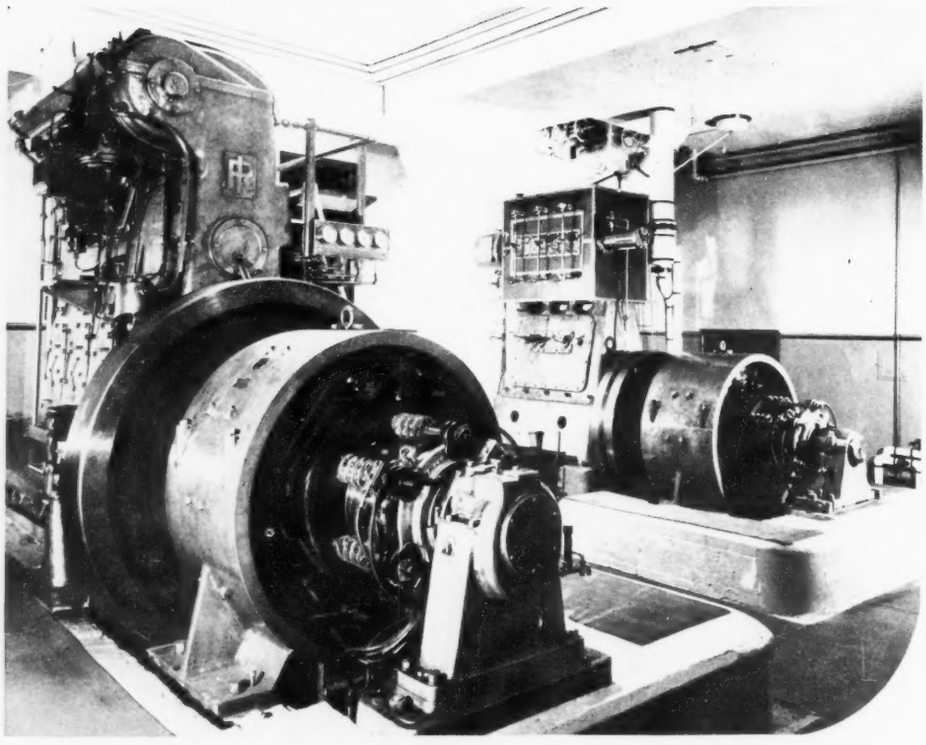
Wheeler Dam, TVA project on the Tennessee River, will soon install the fixed-blade, 45,000-hp., 87.5-r.p.m., 48-ft. head propeller runner above. Because of its 22 ft. diameter, blades and hub are cast separately, then assembled with circular keys and dowels. At right is the 34.5-ft. stay rings designed to support 7,200,000 lb., including generator, concrete and the turbine





Left—Assembly of the 24 gates and their operating mechanism. Over-all diameter of gate spindle circle is 26 ft.

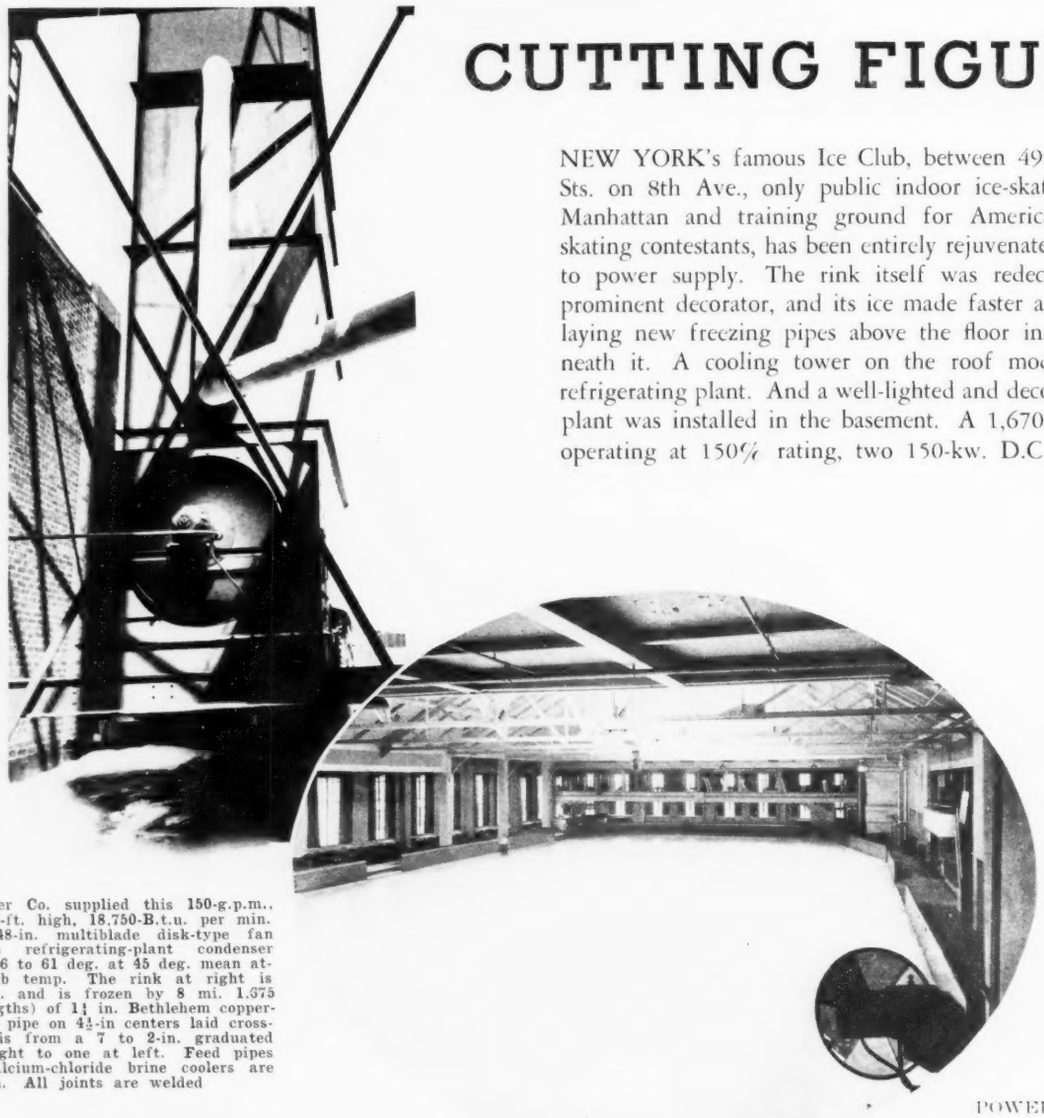
Photographs Courtesy Baldwin Southwark Corp., I. P. Morris Div.



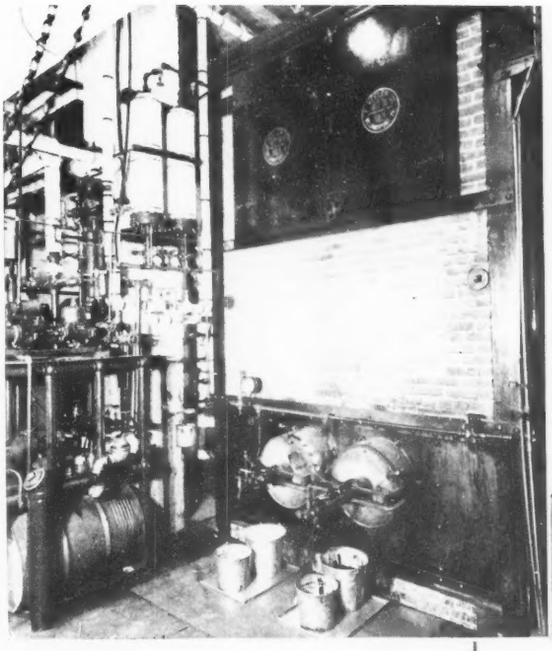
In this attractive engine room are a 3-cyl., 400-r.p.m., 10½ x 11-in., Ames uniflow steam engine and a 225-hp., 4-cyl., 4-cycle, 11 x 18-in., 360-r.p.m., solid-injection Ingersoll-Rand diesel, each driving a 150-kw., 600-amp., 250-volt., welded-frame, Crocker-Wheeler d.c. generator. Wide foundation blocks, only 4 ft. deep due to water level, are isolated with sand at the sides, and below with compressed cork for the diesel and sand for the steam engine. The diesel also has Maxim intake and exhaust silencers, an expansion joint in the subfloor exhaust line (which opens into the boiler stack), and an American air filter on the intake in an adjacent basement room. All piping is welded

CUTTING FIGURES

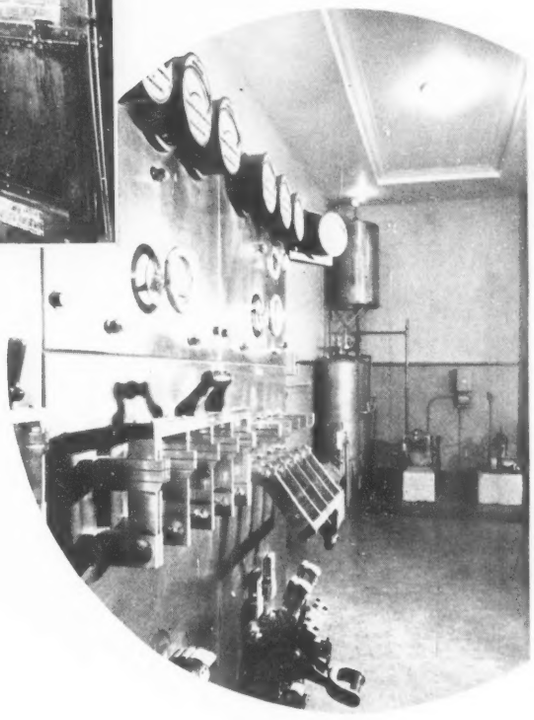
NEW YORK's famous Ice Club, between 49th and 50th Sts. on 8th Ave., only public indoor ice-skating rink in Manhattan and training ground for America's Olympic skating contestants, has been entirely rejuvenated from rink to power supply. The rink itself was redecorated by a prominent decorator, and its ice made faster and better by laying new freezing pipes above the floor instead of beneath it. A cooling tower on the roof modernized the refrigerating plant. And a well-lighted and decorated power plant was installed in the basement. A 1,670-sq.ft. boiler operating at 150% rating, two 150-kw. D.C. generators,



Cooling Tower Co. supplied this 150-g.p.m., 6 x 12 x 22-ft. high, 18,750-B.t.u. per min. unit with 48-in. multiblade disk-type fan which cools refrigerating-plant condenser water from 76 to 61 deg. at 45 deg. mean atmos. wet-bulb temp. The rink at right is 80 x 189 ft. and is frozen by 8 mi. 1.375 standard lengths) of 1¼ in. Bethlehem copper-bearing steel pipe on 4½-in centers laid crosswise. Flow is from a 7 to 2-in. graduated header at right to one at left. Feed pipes from the calcium-chloride brine coolers are 7 in. All joints are welded



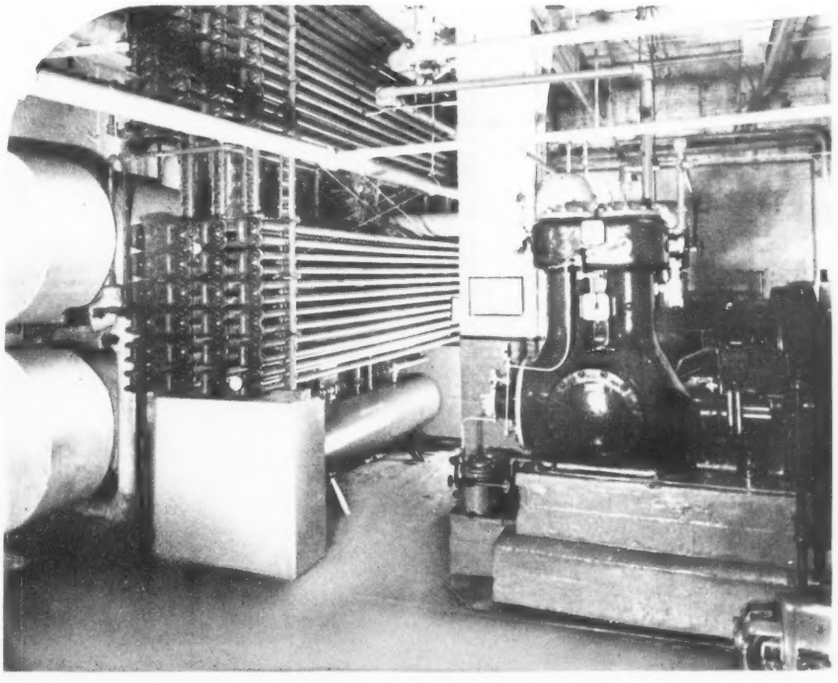
A 1,670-sq. ft. Keeler straight-tube boiler generates saturated steam at 185 lb. Fuel-oil fired through two Coen burners, it has a Copes feedwater regulator, Ellison draft gage, steam- and electric-driven fuel-oil pumps, Bayer soot blowers and Yarway blowdown valves. It supplies steam direct to the uniflow. Engine exhaust at 1½ lb. is piped to the old low-pressure steam header in front of the boiler, with a branch line to an open Worthington feedwater heater on a platform 8 ft. above two 5½ x 3½ x 5-in. Worthington feedwater pumps. An atmospheric relief line runs from heater to stack. A reducing valve supplies 10-lb. steam to a Childs restaurant, and one of the two old boilers provides a standby



Below—Diesel auxiliaries in background include a DeLaval centrifuge (one also for the steam engine) and an Ingersoll-Rand starting-air compressor, both GE motor driven, and a thermostat-controlled valve and Cameron Motorpump to recirculate a varying amount of 135-deg. jacket exit water to maintain intake water temperature at 115 deg., supplying waste water by Worthington triplex-plunger pump to building hot-water services. Above is a lubricating oil storage tank. The 4-panel Empire switchboard has one panel for each prime mover, a small power-and-light panel and a heavy power panel. Norton instruments, a Sangamo wattmeter and Cutler-Hammer voltage regulator are used. Multipoint voltmeter at upper center. Electrical work was done by D. Coyne

IN THE ICE BILL

one driven by a 240-hp. vertical uniflow, the other by a 225-hp. diesel, switchboard, feedwater heater and regulator, etc. were installed. This combined steam-diesel plant provides excellent heat balance, as indicated by the operating cost figure of $0.0075 per kw.-hr. during the past two months, with about 84,500 kw.-hr. generated per month. During the summer, when the rink is not in use, the diesel alone will furnish light and power for the building. Power for two elevators and a.c. for neon signs is still purchased. Harry J. Smith, supervisory engineer for the owners, designed the plant and supervised its installation.

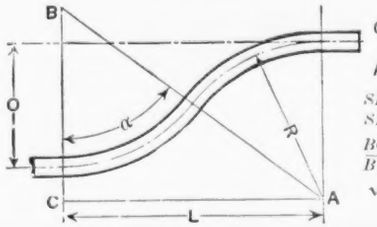


This 70-ton York refrigerating plant, installed in 1928, includes two 2-cyl., vertical, 10 x 10-in., inclosed-type, single-acting, ammonia compressors driven by 75-hp. motors through flexible-idler belts at 268 r.p.m. Two brine coolers superposed against the opposite wall and a vertical counterflow double-pipe condenser complete the plant. Two centrifugal 250-g.p.m. motor-driven pumps supply the system with brine. After the rink closes at 11:30 each night, mechanical scrapers take off ¼ in. of scored ice. New water flowed on is frozen beginning at 4 A.M., to get the rink in condition by 7:30. The rink is in use only 6 mo. per year

© POWER

Length of Pipe Required to Make an Offset Bend

PIPE SIZE	Recommended RADIUS, IN.	OFFSET — IN. 4	6	8	10	12	14	16	18	20	22	24	30	36
1	7	10.85	13.48	15.78	17.98	19.90	.....	.....	.....					
1¼	8	11.54	14.32	16.76	19.00	21.08	23.16	.....	.....					
1½	10	12.86	15.91	18.56	20.94	23.18	25.31	27.42	29.40					
2	12	14.03	17.30	20.22	22.80	25.14	27.40	29.64	31.60					
2½	14	15.15	18.64	21.64	24.42	27.00	29.36	31.60	33.80					
3	18	16.98	21.10	24.52	27.44	30.60	32.92	35.20	37.76	40.00	42.28	44.36	50.60	.....
3½	20	18.04	22.22	25.72	28.91	31.82	34.48	37.12	39.57	41.88	44.16	46.16	52.71	58.82
4	24	19.88	24.30	28.20	31.60	34.60	37.60	40.40	43.00	45.60	47.98	50.30	56.90	63.20
5	30	21.90	27.05	31.24	35.09	38.57	41.80	44.81	47.73	50.53	53.06	55.67	62.83	69.54
6	36	23.90	29.60	34.20	38.40	42.20	45.70	48.96	52.00	55.00	57.80	60.60	68.20	75.40
8	54	29.64	36.16	41.80	46.90	51.02	55.60	59.60	63.04	67.00	71.00	74.20	81.40	92.00
10	66	32.40	37.60	46.10	51.90	56.42	61.40	65.80	69.60	73.40	77.40	80.80	90.50	100.00
12	84	36.80	44.60	51.90	58.68	63.60	69.00	73.80	78.40	82.80	87.00	91.20	101.60	112.00
14	96	38.70	46.96	55.00	61.40	68.20	73.60	78.80	84.00	88.20	92.20	96.80	108.20	119.20
16	120	43.40	53.80	61.80	69.90	76.20	82.40	89.00	93.50	98.50	103.50	108.20	120.50	132.50
18	132	45.60	56.20	64.80	73.60	79.20	86.00	92.20	97.50	102.80	108.40	113.00	126.80	139.50
20	144	48.20	59.00	67.80	76.40	83.00	89.60	96.00	102.20	108.00	113.60	118.20	132.40	145.80
24	180	53.50	64.40	75.40	84.00	94.20	102.00	108.00	113.20	120.00	125.60	131.40	147.00	162.20



GIVEN R & O TO FIND ANGLE α & L

$SIDE\ BC = 2R - O$

$SIDE\ AB = 2R$

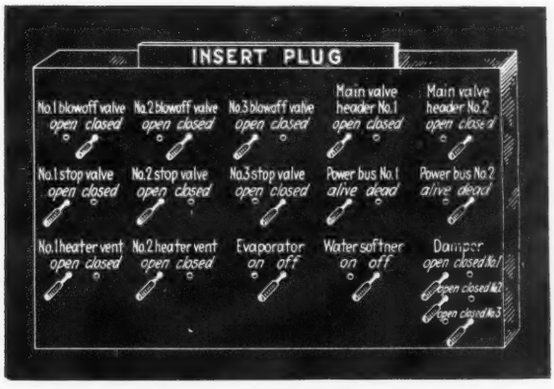
$\frac{BC}{BA} = Cos \angle \alpha$

$\sqrt{AB^2 - BC^2} = AC \text{ or } L$

NOTE: USE SAME SOLUTION FOR OFFSET BENDS WITH RADII OF UNEQUAL LENGTH

By G. W. Purdy

PRACTICAL AIDS TO OPERATION


INSERT PLUG
No.1 blowoff valve open closed
No.2 blowoff valve open closed
No.3 blowoff valve open closed
Main valve header No.1 open closed
Main valve header No.2 open closed
No.1 stop valve open closed
No.2 stop valve open closed
No.3 stop valve open closed
Power bus No.1 alive dead
Power bus No.2 alive dead
No.1 heater vent open closed
No.2 heater vent open closed
Evaporator on off
Water softner on off
Damper open closed No.1
open closed No.2
open closed No.3

Panel Board Shows Operating Conditions

MANY boiler plants operate 24 hr. a day. During the night one or more boilers may be taken off the line, according to load requirements. In these plants, engineers going off duty are usually accustomed to giving detailed information to their relief operator regarding conditons when changing shifts. Oftentimes some detail is forgotten, usually through forgetfulness or because of the operator's hurry to get away.

A panel board like that in the figure has been used to good advantage in one plant for keeping record of equipment operation. A pair of holes are provided in the panel for each major valve or switch control, and a separate plug for each pair of holes is attached. These holes are marked legibly as indicated, but the individual arrangement should be varied to suit each power plant.

Every time a change is made in one of the major valves or switch controls other than momentary, the plugs should be changed accordingly. The operating personnel should be held strictly to account for indicating these changes on the panel. While the board should not be depended upon to the extent that operators neglect to check conditions, it is a useful method to keep track of boiler-plant operation, especially at time of changes in regular operating schedule.

Chicago, Ill. R. O. BILLINGS

Priming Pump Too Quickly Caused Trouble

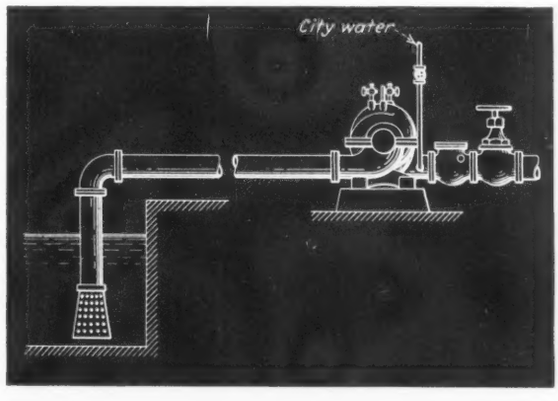
THE centrifugal pump in the diagram takes water from a swimming pool and circulates it through filters not shown. When starting, a city water connection was used to fill the suction line. During the first season, operation was satisfactory, then the lines were drained and the plant shut down for the winter. Next season the pump seemed to be losing its suction repeatedly, and even when running did not operate as smoothly as in the previous year.

Investigation showed that the method of priming used by the engineer caused the trouble. He opened the city-water connection until the open petcocks on the top of the pump case showed water flowing, then close them, and started the pump motor. While this practice was in general in accordance with starting instructions, the type of installataion required a slight change. City-water pressure was 50 lb., and when this valve was opened, the rush of water seemed to compress the air that had accumulated in the long suction line. Even though the petcocks showed water flowing and indicated that the pump case was full of water, the suction line still contained a lot of air.

To correct the fault, priming was done by merely cracking the valve on the city-water connection, so that water flowed in slowly to allow the air to flow out of the petcocks on the pump casing. Priming was permitted to continue longer than would ordinarily be necessary, in order to make sure that all air in the suction pipe and pump was removed. Then the petcocks were closed and the pump started and operated satisfactorily.

Operating instructions furnished with the pump read: "Open the petcocks on the top of the pump case, and fill the pump and suction line with water till the petcocks show water flowing freely, which indicates that the pump is primed. Then close the petcocks and start the pump."

Strictly speaking, the operator followed these instructions



rigidly, and ran into trouble. The pump company has since revised these priming instructions as follows: "Open the petcocks on the top of the pump case, and fill the pump and suction line with water slowly, until all the air has positively been exhausted from the pump and suction line. Then close the petcocks and start the pump."

New York, N. Y. FRANK A. KRISTAL

Operating Soot Blowers on Pulverized-Coal-Fired-Boilers

IMPROPER soot-blower operation frequently causes such troubles as loss of ignition at the burners, major furnace explosions, minor explosions or puffs, and dislodged baffles. The general procedure below will avoid many of these mishaps:

1. Before operating soot-blower elements, increase the opening of the uptake damper and speed up the induced-draft fan, if any, until furnace draft is 0.4 in. of water. In most cases this draft is sufficient to prevent puffing out furnace gases around burners and observation doors during soot-blower operation.

2. Check furnace conditions for steady flame and suffi-

ciently high rating to prevent loss of fire when operating the soot blowers.

3. Open drain valves on soot-blower piping and drain all water from the lines. After warming up this piping leave these valves in a cracked position and put normal pressure on the lines by opening the master steam-control valve. Leave drain valves cracked until soot-blowing is completed.

4. Adhere closely to instructions furnished by the soot-blower manufacturer. Operate the element in the pass nearest the furnace first, but be careful! Under normal-load conditions, operate the element very slowly, observing furnace conditions throughout the arc of travel. If the element is operated too fast and too much fly ash is dislodged at any one time, a puff may result.

Under light-load conditions or when a boiler is first put on the line, operate this element preferably with reduced steam pressure several times before applying full pressure and proceeding with normal operation.

5. When operation of the first-pass element has been completed, blow the remaining elements. Work in numerical order, starting at the first pass and following the travel of the gases. Operate only one element at a time.

6. After all elements have been completed, close the master steam valve. Make sure this valve is tightly closed to prevent leakage into the piping and elements.

7. Open all drain valves in the soot-blower piping.

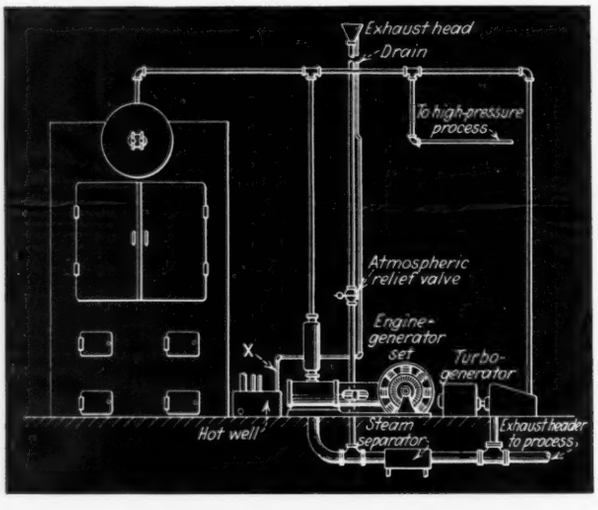
8. Restore furnace conditions to normal.

Waynesboro, Va. S. H. COLEMAN

Saving Exhaust-Head Condensate Proved Expensive

A MID-WEST plant had trouble with its boilers under rather unusual circumstances. The boilers are of the longitudinal-drum, sectional-header type, fired by underfeed stokers. Steam is supplied to a 500-hp. cross-compound engine, a turbo-generator unit, and indirect heating for several industrial-process operations. Exhaust from the engine, which was operated at infrequent periods mixed with the turbine exhaust after passing through a separator. A branch line from the engine exhaust went to an atmospheric-relief valve, as in the diagram.

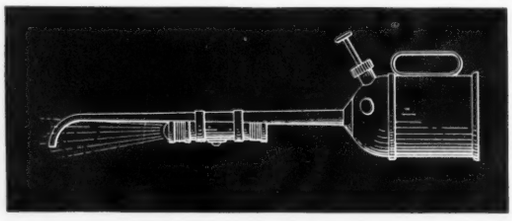
It was noticed that the atmospheric exhaust-head drain pipe discharged a small stream of condensate to the sewer. Having in mind that economy called for reclaiming all possible heat units, the drain pipe was changed to discharge into the hot-well receiver as at *X*. About six weeks later, without warning, a lower-row tube in one boiler split open under full pressure. Fortunately no one was injured, but an expensive repair was necessary because the boiler emptied itself in a short time and was badly burned. Leakage started from several riveted seams in the drums, and a number of tubes were distorted so badly as to require renewal. Most of the remaining tubes required rerolling.



Investigation disclosed that all internal surfaces of the boiler drums and tubes were heavily coated with cylinder oil. All bottom-row tubes were bulged so that they had to be renewed. Similar oil deposits were found in other boilers, and a number of bottom-row tubes bulged and required renewal. All boilers had to be boiled out with a caustic-soda solution to remove oil deposits, and returns from the hot well were waste for several weeks until the oil in the piping was removed.

Needless to say, the oil came from the drain from the atmospheric-valve exhaust head, the condensate from which had been reclaimed to conserve several dollars worth of heat units. This is another example of the advisability of comparing theoretical savings with practical engineering.

Columbus, O. J. R. WILLIAMS



Puts Light on Oil Can

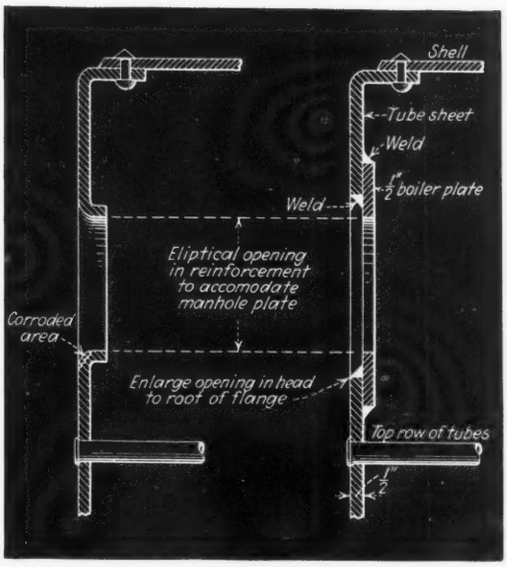
AN OILER who had trouble in locating oil holes in and under a large machine where the light was dim got tired of dragging an extension light with him and tripping over the cord now and then for good measure. He taped a small flashlight to the spout of his oil can, as in the figure, placing it so that the light would shine in line with the tip of the spout.

Omaha, Neb. EMIL J. NOVAK

Electrical Welding Repairs Manhole Flange

HORIZONTAL tubular boilers with a manhole in their front tube sheets above the tubes, may still be found operating in many small plants, especially for heating service. Leakage past the manhole-plate gasket often continues for a considerable time unnoticed. This moisture in the presence of sulphur-bearing soot forms sulphurous acid that corrodes steel. If such a condition exists long enough, the tube-sheet at a manhole flange may be so reduced that it will fail in service.

Welding of a defective area in this location is not usually practicable. The diagram shows a method of repairing a manhole flange deteriorated so that it cannot be made tight. The defective flange is cut out of the tube sheet with an acetylene torch. This generally necessitates enlarging the opening about 1.5 to 2 in. to give a flat surface all around the hole. The edge of this opening is squared off by a pneumatic chisel, if available, or by a hand chisel and file or by



grinding. An elliptical piece of boiler plate is secured, having a thickness about equal to that of the tube sheet, and of dimensions to overlap the tube-sheet opening by not less than 2 in. The opening of this piece should have the same dimensions as the original manhole opening. This plate is held in position inside the tube sheet and its edges are then welded inside and out.

While this plate has some stiffening effect, its strength is not equal to that of a standard manhole flange, but is satisfactory for low-pressure heating boilers, up to about 25 lb. per sq.in. It should not be used for high-pressure power boilers.

Cleveland, O. A. C. WIGGINS

Cork Ball Indicates Water Level

WHEN a water gage glass is dirty, or located where the light is dim, it may be quite difficult for the fireman to see water level. This can be avoided by placing in it a small round ball of cork about $\frac{1}{8}$ in. smaller in diameter than the inside diameter of the glass tubing. The cork should be shellacked and dried thoroughly before being put in. It will ride the water column, keep the scum off of the glass to a certain extent, and is much easier to see than the water-surface line.

Omaha, Neb. EMIL J. NOVAK

Fan-Blade Protection

WE HAVE four large induced-draft fans on our cement-kiln boilers, subjected to rapid wear by dust drawn from the kilns. They require frequent blade and fan-casing renewal, which is quite expensive aside from the time lost for repairs.

Refractory cement, such as is used in furnace work, had proved satisfactory to seal small holes eroded in the fan casing. I decided to try this cement as a protection for fan blading and interior. After renewing the blades and part of housing, I made up a mixture of Brick-lock cement to the consistency of thick buttermilk and applied it with a large paint brush to the wearing side of all blades. I put on several coats, allowing time for each coat to dry thoroughly. The coating should not be more than $\frac{1}{32}$ to $\frac{3}{64}$ in. thick.

It is surprising how this coating will wear and protect the metal. We have not had time to prove its life and the maximum time required before recoating. It is apparent, however, that it will more than double fan life and possibly eliminate blade and housing renewals if properly looked after and recoated at the right time.

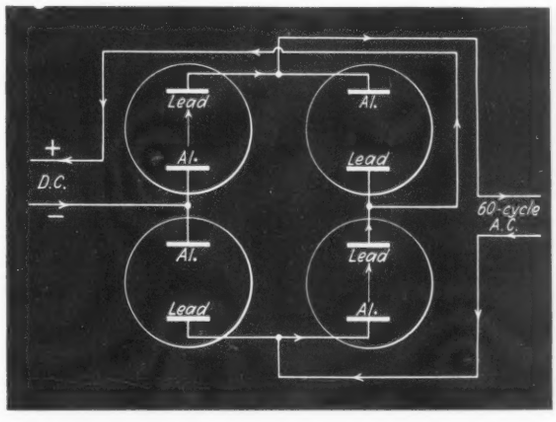
The cement can be sprayed on if a gun is available. This will require more time and several more coats to get the desired thickness, as the mixture will have to be thinner.

Osborn, Ohio J. B. LINKER

D.C. Obtained With Electrolytic Rectifier

THE ENGINEER of a manufacturing plant was recently called upon to supply the research laboratory with 60-volt d.c. This current was to be used for a short period and would then be no longer required. A motor-generator set was thought to be too expensive, as was the rental and frequent recharging costs of a bank of storage batteries. Finally the solution was found in an old handbook.

At a cost of only a few dollars, an electrolytic rectifier was built to supply the needed current. Electrodes of lead and aluminum were suspended in four earthenware jars containing an electrolyte composed of a saturated solution of ammonium phosphate and connected as shown in the diagram.



Action of an electrolytic rectifier is based on the film of aluminum hydroxide which forms on the aluminum plate. This film presents a very high resistance to the current when flowing in one direction. When an individual cell is supplied with alternating current, half of the wave will be suppressed and an intermittently pulsating current will be obtained. By connecting a series of cells in opposed pairs, as was done in this instance, both halves of the current wave are utilized. Arrow heads show current-flow direction at one instant.

Richmond, Va. C. R. ANDERSON

Preventing Mercury Loss

OFTEN while I was using a mercury-filled, open-end, U-tube manometer for pressure measurements, an unexpected pressure surge expelled the mercury from the open end of the tube. To avoid loss of the mercury and the mess it made on the floor, I placed one end of a rubber tube on the open end of the manometer and its other end in a container open to atmosphere. Then, in case of a pressure surge, the mercury is ejected into the container and not wasted.

Cleveland, O. W. G. SECK

CURRENT COMMENT

Federal Licensing Again

I HAVE read the comments on Mr. Robinson's proposal (*Power,* Sept., 1935). I must take the stand that Frank H. Browning (*Power,* Jan., 1936) is right. My idea is that we are past the old rule-of-thumb, red-headed and strong-backed man, who if he were able to whip the men under him, had all that was required.

What happens where they are no license laws? Any company who needs a fireman just picks up the first man that comes along and tells him to fire this boiler. Maybe there is an operating engineer at this plant, but he cannot be with the new fireman every minute; he is a busy man. The results are: low water, burnt plates, tubes pulled out of drums, the fireman scalded and property damaged. Who gets the blame because the man was not properly trained? The engineer, if there was one on the job. Respect for his ability has taken a slump.

In examinations, why technical questions? The operating engineer has nothing to do with the design and strength of a boiler. If the state in which he operates has a boiler code, it is up to the state inspectors to see that the manufacturer builds according to that state's Code. The license will show that a man has served his apprenticeship and is qualified in present-day safe methods of operation.

I believe that there should be a state license law and not federal, as at the present time the trend is that it would be unconstitutional. I am not sure of this, for I am not a lawyer.

Sherburne, N. Y. CHARLES F. CANTER,
Engineer, Utica Knitting Co., Mill No. 5

Still More on Federal Licensing

MR. TOWSE (*Power,* Jan.) advocates a future status that would place engineers actually operating in power plants on a plane far above that which they would desire. We engineers who have served our apprenticeships in the machine shops or shipyards, progressed through the priceless training of ocean "tramp" service and, eventually, given our wives a treat by coming home every night from a stationary position, do not wish to be classed as members of a higher hierarchy. We are proud of the hands that are able to operate the plants under our charge economically. If necessary, we can apply our long practical training to work in a garage, at sea or as an ordinary machinist if our power-plant work fails. This is a very big asset, and any attempt to change it would be resented by the more far-sighted of us.

The local examiners we have now are usually men who can appreciate these qualities and the very narrowness of their sphere of action renders them more capable of passing on the requirements and capabilities of the applicants than any Washington examiner, however well meaning.

A good engineer must go through the mill of machine-shop training and subsequent marine service for his own sake. If all his training has been with a view to gaining a professional license he will be rather a helpless person when a period of business slackness closes his place of employment. During the depression, engineers, the whole world over, have suffered less than any other trade solely because their training was practical, and they were able to turn their hands to other kinds of work which the higher and more technically trained man could not do. They, unfortunately, had to sit back and wait for economic conditions to improve.

Mr. Koontz (*Power,* Jan.) rather arouses my pity. He refers to poorly paid engineers and says that the "recipients are not worth more." If his study of industrial conditions and economics has been so little as to make him believe that "ability controls wages in 99 out of 100 cases" he is more an object of commiseration that a potent factor in any discussion.

Mr. McIntosh (*Power,* Jan.) cites the British system of licensing. His letter, asserting political influence, is, strangely enough, from the same state as that of another contributor who says that such influence is not felt. From my own personal experience in Ohio I am strongly inclined to side with the latter opinion, as I always found the examiners there to be very competent and conscientious men.

Whilst admitting that the British system is unsurpassed, we must remember that this country is so vast that such a scheme might be quite unworkable; then again, what about state's rights? The most potent factor militating against any adoption of the British system with good results here is the fact that the British Civil Service is absolutely, entirely and irremediably removed from political influence. I rather fancy that desirable state is not fully in operation here.

It is much better for competent local examiners to pass upon applicants in their own states. If any subsequent catastrophe shows that an incompetent has been permitted to operate we have the examiner right where we can get hold of him and ask his explanation, whereas, if a Federal inspector were concerned, he would, probably, be unavailable for questioning or, if available, protected by Federal position from state correction.

Surely we saw enough of the Federal inspectors and their actions during the Prohibition era and how impossible it was to get them before the Courts even when they were accused of the most heinous misdemeanors. The Federal Government can always, and will always, by transferring its men from a state's jurisdiction, keep them free from awkward questions. I feel sure the same thing would happen if Federal men were allowed to pass on our applicants for licenses.

Let us keep to the present system which is working well. Let us not forget, even with the well-known American short memory, that Federal Inspectors licensed the men who have just been found guilty for their exploits on the *Morro Castle,* and, until we come across evidence of such loose licensing in our stationary services, let us keep the reins in our own hands.

Passaic, N. J. MARK BELL

Mr. Robinson's Reply

COMMENTS on my suggestion to have the Federal Government license stationary engineers were read with great interest. Regardless of the personal opinions voiced, it is evident, from the number of comments sent in, that most operating engineers feel that some improvement over the existing condition is desirable.

As stated in my letter to *Power,* the suggestion was only tentative, and constructive criticism and discussion of this subject was invited. Most of the letters received were along these lines.

I have followed closely the activities of the various engineering societies in their drive towards professional recognition, and I repeat, they have almost completely disregarded the operating, or watch, engineer in this matter. Admitted that, in some instances, they have provided means whereby the self-trained practical man may acquire professional standing, but at the expense of almost a lifetime of study and preparation. I have no quarrel with the man who is now known as a professional engineer. In fact, I admire him immensely. He is the designer, the research worker, he is our chief engineer of power plants and large central stations, and our engineering salesman. He is needed; he has a definite place in the profession. But so has the operating, or watch, engineer.

It takes intelligence, training, and quite some technical knowledge to take charge of a watch in a power plant, large or small, even if he didn't design or build it. And as long as there are steam power plants, there will have to be watch engineers. Why should he be required to learn subjects that will be of no use to him in his chosen branch of the profession. Better that he concentrate on being a first-class watch engineer, worthy of the trust and confidence placed in him by his chief. After attaining that goal, then if he wishes he may prepare himself for further advancement. We can't all be chief engineers, you know.

As to whether Federal licensing is practical or not—I believe it is. At its worst it is better than the present system. The Federal licensing system for the marine service is as a whole, excellent (I have a second assistant's ticket myself). Remember, that what would be regarded on land as a minor incident assumes major proportions at sea. The set-up on a vessel augments this, fuel oil tanks along side of the boilers, etc. Again, you can't just walk away from the plant at sea; you have to stick, and when the going gets tough some men crack. The examiners cannot determine this quality by an examination. In a given set of circumstances no man knows what he will do; he has to be proved. If he fails, the only thing they can do is revoke his license.

Some of the fellows expressed satisfaction with the present "state" licensing system. Did you know that less than half of the states have a license law? That the rest of the states leave that little matter up to the individual cities? That men operating in one city cannot go five miles away to another city, and

operate, unless they have a license for both cities? And that both cities are in the same state? State licensing, for all states, and a reciprocal agreement between states, might be an acceptable substitute for Federal licensing.

The proposal to call a man an "engineer" and then leave it up to the man's honesty and professional integrity to practice only in that branch of the profession he is qualified for is fine for the professional engineer. He is generally a college graduate and has the required basic knowledge of engineering. But how about the non-professional man who studied, say, steam engineering from a correspondence school, and coupled with his practical experience is qualified as a steam power-plant engineer only? He has learned steam engineering thoroughly, and is second to none in this branch of engineering, but, he knows very little about diesel engines, air conditioning, refrigeration, and practically nothing about engine design on internal-combustion engines or the higher branches of heat engineering. Would this circumstance indicate that this man had no right to recognition as an engineer? I don't believe that it would.

And finally, as to constitutionality, I believe that if most of the operating, or watch, engineers in the United States want a Federal or universal state licensing law, they can get it. It is obvious that plant owners and operators will be benefited by such an arrangement.

St. Louis, Mo. CHESTER G. ROBINSON

Cutting In a Boiler

MR. MYERS' comments on drains and non-return valve are excellent, as far as they go. Yet these are far from universal in small plants, and we await the happy day when the average operator reaches Mr. Myers' evident attainments. Modern devices are truly marvelous, as long as they work right, but good judgment demands methods that are still safe when things fail to work promptly or properly.

The chapter in October, 1935, *Power* on Cutting In a Boiler *without* non-return valves, is but one of several discussions on the greatly neglected actions inside a working boiler. The condensate at the stop valve is the most obvious argument to many engineers, but the behavior of the hot boiler water is the most misunderstood.

Stated very briefly, there is, contrary to the general belief, practically no circulation before the outlet valve is opened, because the amount of steam being made is negligible. Remember that all the heat is stored in the water and this produces steam to match the amount escaping, without the slightest relation to the fire. If the non-return or main stop valve opens slightly above line pressure, surprising quantities of steam must escape before pressures equalize. This sudden production of steam, without good circulation, occupies a large space below the water surface, forcing the level toward the main outlet.

The very best procedure I know is the merchant marine practice—open the auxiliary header valve when a few pounds low, let pressures equalize, start circulation with this moderate flow, and then open the larger main stop valve. To make dead sure of dry steam, always cut in the boiler enough below the line to allow for any errors of gages. A moderate bypass on the non-return valve, or positive means for lifting the non-return just before pressures balance, would allow this. With active circulation ensured, a well-designed boiler can handle severe demands without serious disturbance of water level.

Seattle, Wash. FRANK H. BROWNING.

Feedwater Treatment

I HAVE *recently been supplied with a supply of boiler treatment composed of the following chemicals: 82.4% sodium carbonate; 5.0% tri-sodium phosphate; 2.6% tannin, and the balance water of crystallization. I have been instructed to use this material in the quantity of ½ lb. per 1,000 gal. of water used in the boiler. A friend of mine who is a chemist, and who has made quite a few tests on local water, suggests that 3 lb. per 1,000 gal. would be more suitable.*

Have you any comments or suggestions that you could give me relative to the efficiency of this formula for the prevention of scale and pitting in the boilers, and what test or tests should be made at intervals to indicate whether or not this treatment is maintaining the proper alkalinity of the boiler water? The heating system of my building is operated usually under 10 in. of vacuum on the pumps, and 4-5 in. of vacuum on the boilers. Any information you can give on this subject will be appreciated.—A.E.T.

[The following answer to the question of A.T. was prepared by Mr. Wm. J. Ryan, Water Service Laboratories, Inc., 247 East 56th St., New York, N. Y.]

Without knowing the analysis of the water, it is impossible to say how much of this mixture should be used per thousand gallons of make-up. If the supplier of the chemical mixture made his recommendation of quantity to be used, without considering the analysis of the water, it would seem preferable to accept the recommendation of the chemist who is evidently familiar with the water.

This mixture of chemicals, if used in proper amounts, is capable of preventing hard scale and retarding corrosion. However, if the water is hard enough to require 3 lb. of the chemical mixture per 1,000 gal. of make-up, and if there is much make-up water fed, a big bit of sludge will be formed which must be blown down or washed out at intervals. This should be particularly kept in mind if there is already an accumulation of scale in the boiler which may be loosened by the treatment.

Briefly stated, the test for total alkalinity consists of adding to a 100 cc. sample of water, in a white porcelain casserole, a few drops of methyl orange indicator which imparts an orange tint to it, and then adding from a burette sufficient 0.02N sulphuric acid until the orange color just changes to a faint pink. The methyl-orange alkalinity (expressed in parts per million as $CaCO_3$) of the water being tested is equal to the number of cubic centimeters of acid used multiplied by 10.

The test is simple and can be performed in a few minutes, but before proceeding it would be well to consult the chemist for detailed instructions for performing it and also for advice about interpreting the results.

Self Expression in Plant Operation

ROUTINE power-plant operation should be humanized as much as possible. Aside from the special duty of each operator, there are numerous tasks that can be done or left undone. Some who work willingly, frequently find that more is given them to do.

In most plants there are items such as paper work, stock, tools, leaks, oiling, filters, drains, painting, insulation, regulators, records, and cleaning up that may be neglected for days. These can be divided according to the talent and ability of men.

Most men like to do their part, but they expect to get credit for it.

Hodge, La. I. C. WEST

Pump Trouble May Be Due to Something Else

IN THE August, 1935, *Power*, a correspondent describes a pump trouble, and a solution is offered by *Power*. The solution would seem to presuppose that the jumping takes place when the pump is being started, but the case as stated does not justify such an assumption. That the trouble is due to the liberation of air during the suction stroke does not look quite reasonable.

No doubt air is liberated, but, since the liberation takes during the suction stroke, the globules of air, if they are large enough to be honored by the name globules, will be expanded so that the turbulence of the water entering the pump chamber will prevent any accumulation of air. Besides, it is well known that air in contact with water, especially if it is under pressure, will be absorbed by the water. This absorption is so serious that in the operation of hydraulic elevators a layer of oil is sometimes maintained on the surface of the water in the tank in order to prevent it. So it is evident that while liberation may take place, absorption is also present.

It is more reasonable to suppose that the trouble is due to shoulders on the plungers if it is a plunger pump, combined with hard packing, and the packing is very likely to be hard if shoulders are present due to the tendency to screw her up a little tighter in order to prevent leaking. If it is an inside-packed pump, the shoulder will be in the liners. The remedy is to true up the plungers or liners. Anyway, that's what we do, and the trouble disappears.

Another cause of jumping is hot water, with, perhaps, overstiff suction valve springs. The remedy in this case, if the water is not too hot, is to reduce the tension on the springs. Tension on all the valves of a set should be equal. For a double-acting duplex, there would be four sets of springs. If the water is too hot for the trouble to be remedied by adjusting the springs it will have to be cooled, if possible without loss of heat. We pump water at 220 deg. F. without any trouble with a 10-in.-stroke pump running at 200 strokes a minute.

Still another possible cause of jumping is too many elbows in the suction pipe, and if, in addition the water is hot there is pretty sure to be trouble. In one plant I removed more than a dozen elbows from not more than 10 ft. of suction pipe, and the pump worked better after it.

Toronto, Ont. R. MCLAREN

READERS' PROBLEMS

QUESTIONS for Our Readers

Oil in Boilers

Question 1

WE HAVE *been troubled from time to time with oil in our boilers, and recently on opening the boilers for cleaning and inspection, we found soft scale deposits. What simple and practical test can we apply to these deposits to determine whether there is any oil in them?*—H.M.S.

Generators Won't Synchronize

Question 2

IN OUR *plant we have three 220-volt, 60-cycle generators which we will call A, B & C. A is made by the Swedish General Electric Co., and has a 187-kva. rating. B & C are 312-kva. manufactured by Mather & Platt, Manchester, England, and supposed to be duplicates. All are driven by Bellis & Morcom compound steam engines. Operation of all three in parallel is satisfactory, also operation of A and B, but A & C cannot be synchronized except by cutting in all three and then taking off generator B. After B is taken off the operation of A & C is satisfactory. B & C go in together nicely and operate satisfactorily together. Any attempt to synchronize A & C results in a momentary voltage drop and a violent swing of the voltmeter pointers. The over-current coils on the generator switches operate, disconnecting the machines even when set at nearly double nameplate rating. We use a synchronoscope regulator. Why can't we synchronize A & C?*—C.McD.

Suitable answers to these questions from readers will be paid for if space is available for their publication.

STUCK TUBE CLEANER

ANSWERS to January Question 1

The Question

WHAT *is the best method of removing a rotary tube cleaner that has stuck in a tube of a bent-tube boiler?*—J.F.

Stuck Cleaner May Damage Tube

WHEN a rotary tube cleaner sticks in a curved tube, it may be driven out by a long flexible rod from one end or the other, provided the cleaner is not jammed too tightly.

Often an accumulation of hard dense scale will cause a tube cleaner to stick, and the scale may be softened by boiling out the internal surfaces of the boiler with a solution of about 75 to 100 lb. of caustic soda per 1,000 gal. of water. This boiling should take place with the boiler vented to atmosphere, and boiled slowly for 24 hr. Frequently this treatment is effective in loosening or removing scale and sediment, and in some cases it is unnecessary subsequently to turbine the tubes. In more severe cases this treatment will aid the turbining process. If scale is causing the cleaner to stick, the caustic soda treatment will loosen it.

In a number of cases a rotary cleaner has been jammed so badly as to gouge into the tube, seriously weakening it. Sometimes a tube will be slightly dented in transportation or in installing the tube. A slight dent in the tube will cause the rotary cleaner to bind at this point and cause additional damage to the tube. Unless it can be positively ascertained that the tube is not damaged, which will be difficult, installation of a new tube is advisable.

Cleveland, Ohio. M. E. WAGNER

Used Penetrating Oil

THE best method to use will depend on individual conditions, such as tightness, whether or not the hose has pulled loose from the cleaner, etc. Several years ago I had a rotary air-driven tube cleaner stick three times in 3¼-in. bent tubes. The first time, the tube cleaner was being fed from the steam drum toward the mud drum, the hose was intact, and the turbine was almost through the tube when it stuck. I poured a half pint of penetrating oil into the tube and allowed it to stand for about ½ hr. Then I turned air on the cleaner and it came free easily. I swabbed the oil out of the boiler tube by pulling a rag saturated with a cleaner through several times.

The second time a circulating tube between two of the steam drums was being cleaned and the turbine hung almost half way in the tube. In an effort to free it the hose pulled off. A spare circulating tube was laid out on the floor and sections of 1½ in. pipe about 2 ft. long were bent to conform to the bend in the tube. More than enough sections were made up to reach the cleaner from the cutter side. A wooden peg or bung made of oak was driven in the end of the first section of pipe to prevent damage to the cutter head. A few sharp blows on the pipe with a hammer loosened the cleaner and dropped it into the steam drum, or rather into the hands of the man waiting to catch it.

The other time, the turbine hung up was in a 3¼-in. tube about 30 in. before it reached the mud-drum where the tube made a short bend. Some round lead washers 2 in. in diameter and 2½ in. high were cast. Enough of these were made to reach from the end of the cleaner around the bend. They were fed up from the bottom of the tube and a piece of pipe was used to hammer the lead washers to loosen the cleaner. Tension was held on it from above by pulling on the air hose.

After this experience, the tubes and drums were thoroughly cleaned down to the metal, and a coat of Apexior was applied to the surface of the drums and tubes. The feedwater was treated, and the scale-forming elements held in suspension. Concentration was kept down by periodic blowdowns. When a boiler was opened it was washed down, and very little tube cleaning was necessary.

Waynesboro, Va. J. M. MEYERS

Heat Boiler Tube

THE best method of removing the rotary tube cleaner is to drive it back in the direction from which it came by means of a rod through the opposite end of the tube. If this fails or is impossible, it would be best to run cold water through the hose and through the machine and heat up the outside of the tube near where it is stuck. Then as quickly as possible, switch to the air if it is an air-driven machine and hammer on the outside of the tube at the same time. If this fails, the only thing left to do is to pull the hose off the machine and try to drive it in the direction in which it was going when it stuck, by means of a rod.

Failing in this respect, the only method of tackling the problem would be to remove the tube. It is assumed of course that an attempt has been made to operate the cleaner and that someone has jerked on the hose as hard as possible.

New York, N. Y. H. L. PARRY
Parry Engrg. Co.

Cast Lead On End of Wire

I RECOMMEND that one work a No. 8 wire past the obstruction to the lower drum. Coil the end and mould with lead in a 2-inch coupling. Now draw back into the tube and hammer the obstruction loose. I have successfully used this method in 3¼-in. tubes.

Tuscaloosa, Ala. S. D. ALLEN

Use Short Wooden Blocks

THE best method found to remove a stuck rotary tube cleaner from a bent-tube boiler is to obtain a piece of hard wood the length of the tube and shape the sides either round or hexagon, about ¼ in. smaller than the inside diameter of the tube. Saw the wood into pieces about 2 in. long so that the blocks will follow the curvature of the tube.

Go inside the lower boiler drum, and in the tube in which the cleaner is stuck place a metal washer about ¼ in. smaller in diameter than the tube and ½ in. thick, and follow behind it with the wood blocks until the metal washer strikes the stuck cleaner. Against the last block place a straight piece of hard wood about 2 ft. long and against it block up a screw jack.

Slowly screw up on the jack, and as the 2-ft. piece of wood gets beyond the straight part of the tube remove it and insert more of the short blocks. This process can be continued until the cleaner is pushed out of the tube.

Wilmington, N. C. G. G. AVANT

FLAREBACKS ON LOW LOADS

ANSWERS to Question No. 2

The Question

WE HAVE *a pulverized-coal installation in our plant. The burners are of the horizontal-cone type and the pulverizers are unit impact machines. On low loads, we have considerable trouble with fires going out, often resulting in flarebacks before the operator can get them going again. What causes this and how can we prevent the trouble?*—H.S.

Increase Primary Air Temperature

I PRESUME that the pulverized-fuel installation of which H. S. speaks is of the single burner type. The average pulverized-fuel mill of the unit type is designed to take care of high ratings and, when it is necessary to operate at an exceedingly low rating, trouble usually arises due to the fact that the percentage of excess air is too high and this causes the flame to become unstable. Often ignition is completely lost.

When this occurs pulverized coal from the mill continues to discharge into the furnace, and when it comes in contact with the high-temperature refractory, ignition takes place and the sudden expansion of the gases causes them to take the line of least resistance. This is usually through the inspection and explosion doors. I would suggest that, when operating at low ratings, secondary air be shut down to a point where ignition is taken care of more or less by the primary air alone. This will result in a more stable flame.

To say the least, this method of operation is rather inefficient, although it is frequently adopted. It would help if fineness were checked, as perhaps the pulverization is too coarse and a greater degree of fineness would materially aid ignition.

Another method by which ignition can be aided at low ratings is to increase the temperature of the primary air coming through the mill. Care should be taken, however, to see that the temperature of the air coming through the mill is not raised too high, as trouble may be experienced with ignition taking place too near to the burner and possibly doing damage. To minimize the danger of flarebacks and possible explosions, it is imperative that the mill be shut off immediately upon losing ignition and then started up again in the approved manner.

Scranton, Pa. J. W. EDWARDS

Too Much Ignition Gap

THIS trouble is almost always caused by too much "ignition gap." Ignition gap is a term used in our plant to denote the distance from the burner tip to the point at which ignition occurs. At normal or high loads it is of little significance except that too much gap may cause the flame to impinge upon the back wall. But at low loads the ignition must be kept as close to the burner as possible without danger of burning the tip of the burner. This can be done by reducing the secondary air, or if necessary, closing it off entirely. Experimenting will indicate the best setting. A good rule is to carry fires at low loads just as when lighting up, that is, supply a rich mixture.

At low roads, I would expect a fire to go out with an ignition gap of 4 to 6 in.—1 in. is far safer.

If the secondary air is closed entirely, be sure to watch the wind-boxes closely as they may fill up with coal. If this occurs, blow them out about once each hour by opening the secondary air dampers (for one burner at a time) to about 1 or 2 in.

Too much feeder-pipe pressure will sometimes cause the same trouble. In any case this trouble is caused by improper air setting. Pulling the flame back to the burner at low loads, keeps the front wall hot and thus insures positive ignition.

St. Louis, Mo. CHESTER G. ROBINSON

Install Bridge Wall

IN ONE of our State Institution power plants there was recently installed a pulverized-coal unit similar to the one H. S. has. And this same question was satisfactorily answered by installing a bridge wall so that it will be heated to the ignition temperature of the powdered coal, yet not high enough to interfere with the combustion chamber.

This bridge wall reaches ignition temperature within a few minutes after starting up. The results are evident. The bridge wall serves as a continuous lighter and does not allow the fire to go out as long as fuel is entering.

The bridge wall is, of course, of high refractory so as not to necessitate frequent replacement. By starting your pulverizer and looking in the furnace with an electric light, noticing the exact path of the fuel you can best determine the location and height of the bridge wall to suit your conditions. (No lighter is applied during this procedure).

Flarebacks are caused by the furnace filling with the powdered coal before it is ignited by some hot place in the furnace walls or by the operator. You must remember, a furnace filled with powdered coal is practically the same as one filled with gasoline vapor.

Greenville, N. C. HENRY I. WEST

Install Refractory Around Burner

TROUBLE with fires going out and resultant flarebacks on light loads is often experienced in an installation such as H.S. describes. This is caused by an intermittent supply of fuel, resulting from an accumulation of the powdered fuel in the fan chamber or the conducting ducts.

In many cases the condition can be corrected by altering the installation to give a long run of straight duct directly behind the burner. Quicker ignition, after the fires go out, can be obtained by the installation of three or four rings of Carborundum brick around the burner. Proper adjustment of the burners will lessen the evil, but the condition cannot be corrected in this manner.

If the light loads are a common occurence, my suggestion would be to call in the pulverizer manufacturers and get their opinion.

Albuquerque, N. M. RALPH J. RAINEY

Maintain High Furance Temperature

FREQUENT loss of ignition at low ratings and the accompanying flarebacks in pulverized-coal-fired burners are the result of two conditions:

1. Improper dissemination of the fuel particles, or streamlining in the conveying air stream, and

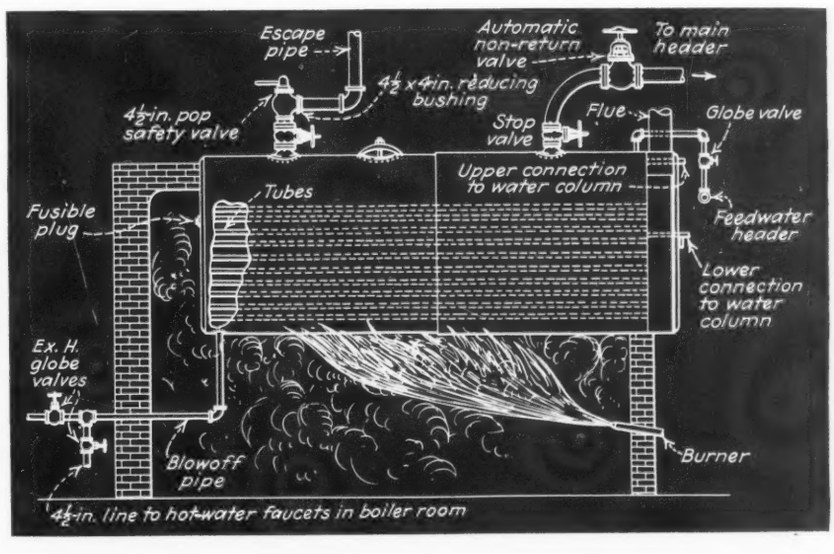
2. Low furnace temperature.

Either or both of these may result in loss of ignition. Given a suitable burner and furnace design for normal ratings, it is inevitable that, as the rating decreases, dis-

WHAT'S WRONG WITH THIS PICTURE?—II

COMMON BOILER ERRORS

THERE are at least 16 mistakes shown in this drawing. Make a list of those you can recognize, then check against the list on the next page



tribution of the fuel particles in the conveying air becomes more and more imperfect and furnace temperature lower and lower.

To reduce streamlining of the fuel particles leaving the burner, increase agitation of the fuel in the primary burner sleeve. Most burners have primary diffusion vanes. Give these a greater twist at their ends, effecting thereby a greater turbulence on leaving the burner, and added impedance on the mill side of the vanes, usually conducive to more general fuel-particle distribution. In twisting the vanes, be sure the amount of twist is not excessive, as this results in a flat, mushroom-type flame at higher ratings.

Maintaining sufficient furnace temperature is more difficult, but equally important. A high temperature within the furnace will usually offset improper fuel dissemination, whereas a cool furnace will always necessitate intimate air and fuel distribution to maintain ignition and a good flame. In an all-refractory furnace, nothing can be done to improve this condition. In a furnace with side water wall protection, the temperature at the burner may be built-up considerably by covering the water wall tubes in an area immediately adjacent to the burner with plastic fireclay,—care being taken to leave sufficient tube surface uncovered within the furnace to maintain reasonable temperatures at high ratings.

If the two corrective measures discussed above are not applicable in this particular instance, a higher volatile coal might be used. Maintaining ignition at low ratings with a low-volatile coal requires ideal mechanical and furnace conditions, and a change in fuel will frequently prove a benefit.

Minneapolis, Minn.

ALBERT E. CANFIELD,
The Strong-Scott Mfg. Co.

Reduce Primary Air

STABLE ignition is dependent primarily upon the ratio of fuel and air in the mixture supplied to the burner, consequently if the mixture becomes too lean, particularly at light ratings, the flame becomes unstable, and "puffs" or flarebacks are likely to occur. Of course, if more than one burner is in operation, stable ignition may be maintained with considerably leaner mixtures than is the case when only one burner is in use, since each supports the other.

The ratio between the maximum and minimum capacities of a pulverized-coal burner of direct-fired systems is usually taken as about 3 to 1. However, even lower ratings may be handled successfully if care is taken in the adjustment of the fuel and air mixture. For very low burner ratings it is usually not advisable to use forced draft. Better success will be had by opening the access and observation doors of the burner housing and operating on natural draft. Furnace draft should be adjusted to an amount sufficient to keep the point of ignition far enough away from the burner parts to prevent overheating and damage to the latter. At low burner ratings it is also usually advisable to reduce the amount of primary air through the pulverizer. This has the effect of bringing the point of ignition closer to the burner due to a reduction in the velocity of the mixture through the burner nozzle.

Another factor which contributes to unstable flame conditions at low ratings is the intermittent operation of some types of pulverizer feeders. Changing from an intermittent to a continuous-feed arrangement will prove helpful in obtaining maximum stability of flame propagation. For example, if the feeder is of the so-called star type driven by a constant-speed motor through a ratchet and pawl arrangement the delivery of coal to the pulverizer will be more or less intermittent, especially at low ratings. This condition may be vastly improved by using a variable speed motor to drive the feeder which may be done either through a belt or chain drive, or the motor may be direct connected to the feeder.

Greensboro, N. C. C. E. KERCHNER

WHAT'S WRONG WITH THIS PICTURE?—II

COMMON BOILER ERRORS—SEE PAGE 163

OUT of every hundred boiler installations, over twenty mistakes of the type shown in the sketch are found. Although some are of minor importance, others may cause serious results. Errors shown, possible operating difficulties, and corrective steps are:

1. *No Drain Between Stop Valves.* Neglecting to provide proper drainage for condensate between two boiler stop valves may result in serious trouble. Water hammer and rupture of steam main or fittings may result when cutting the boiler in on the line. A drain also aids in determining leakage past either stop valve. A drain in sight of the operator should be provided.

2. *Stop Valve in Wrong Place.* The stop valve should be installed on the header or far side of the non-return valve. In case of repairs to this valve when the boiler is off of the line, the main stop valve will close off the header steam and the open drain will give assurance against leakage back past the stop valve.

3. *Safety-Valve Escape Pipe Unsupported.* Where it is necessary to use an escape pipe as shown, a considerable strain may be put on the safety-valve nozzle by weight of piping. A support should be provided for the escape piping.

4. *Bushing in Safety Valve Escape.* Safety valve escapes should run full size with no reduction in diameter. Such a fitting would cause a back pressure on the safety valve when blowing, so that it would immediately close and open again when back pressure dropped. A destructive hammering action would result.

5. *No Drain in Safety-Valve Escape Piping.* An open drain should be provided at the lowest point in the escape piping. Without this drain, water would collect on top of the safety-valve disk and possibly cause delayed blowing or serious water hammer and rupture when it did blow.

6. *Shut-off Valve on Safety-Valve Connection.* Safety valves should be placed as close as possible to the boiler, with no valve of any description intervening.

7. *Flow Pressure Over Disk in Feedwater Valve.* Should the disk become detached from the stem in the feedwater line globe valve, the valve would act as a check. It would then be impossible to feed water to the boiler. The valve should be inverted so that this condition could not arise.

8. *Globe Valve in Blow-Off.* Globe valves should not be used as blow-off valves. They easily become obstructed and inoperative when used with scale- and sludge-filled water. Extra-heavy gate valves, an approved type of blow-off valves or cocks should be used. When pressure exceeds 100 lb., there should be two valves in the blow-off piping.

9. *No Check in Feedwater Line.* A check valve should be provided in each individual boiler-feed line between the feed-water header and feedwater shut-off valve. A second stop valve should be provided between the check valve and feedwater header so that the check may be isolated from pressure when making repairs.

10. *Hot-Water Line from the Blow-Off.* It is very poor practice to tap any such connection off the blow-off piping. Water may be drawn from the boiler without the operator's knowledge. Also the line may be accidentally left open. Either condition might result in dangerously low water in the boiler.

11. *No Rear Arch Clearance.* Neglecting to provide about 1½ in. clearance between the rear tube sheet of the boiler and the rear arch will cause serious expansive strains in the boiler and damage to the arch. The clearance space may be sealed with any plastic insulating material, such as asbestos or magnesia mixtures.

12. *No Clearance Around Blow-Off Pipe.* Neglecting to provide sufficient space around the blow-off pipe where passing through the rear wall causes excessive expansive strains in the pipe and fittings. A pipe or sleeve the next pipe size larger should guide the blow-off pipe through the wall.

13. *No Protection for Blow-Off Pipe.* A brick pier or a substantial, removable, split cast-iron sleeve should protect the blow-off pipe from flame impingement and radiant heat of the fire. Neglecting to provide this protection may cause overheating and rupture of the pipe.

14. *Lower Connection to Water Column Too High.* Paragraph p-322 of the A.S.M.E. Power Boiler Code states that the water connection to water columns shall be taken from a point not less than 6 in. below the center line of the shell. Safe and accurate operation of the gage glass and water column require that this rule be observed.

15. *Burner Position Wrong.* The burner should be adjusted and set so that there will be no flame impingement on any part of the boiler. Such flame impingement and scrubbing causes a serious localization of heat. Bulging or even failure of the boiler at this point may result.

16. *Fusible Plug too Low.* In the horizontal tubular boiler the fusible plug should be located in the rear tube sheet not less than 2 in. above the top row of tubes.

Boston, Mass. HARRY M. SPRING

THE ENGINEER'S BOOKSHELF

Elementary Thermo

ELEMENTARY ENGINEERING THERMODYNAMICS (1936)—*By Vincent W. Young, associate prof. of mech. engrg., Okla. Agr. & Mech. College, and Gilbert A. Young, prof. and head of the school of Mech. Engrg. Purdue University. Published by McGraw-Hill Book Co., 330 West 42nd St., New York, N. Y. 220 pages, 6x9 in. Many illustrations. 8 tables and two tipped-in plates (temperature-entropy chart and Mollier diagram). Price, $2.50.*

Primarily for engineering students, this book is intended as a text for the theoretical portion of heat-work instruction preliminary to or concurrent with study of the practical aspects. For mechanical engineering students, these courses form the basis for later more detailed and more specialized instruction in such subjects as power-plant design and testing, internal-combustion engines, refrigeration and air conditioning.

Brief and uncomplicated, yet fairly comprehensive, the work is logical in treatment and includes many illustrative examples. The authors have devoted special attention to problems which cause the average student considerable difficulty, and have included a chapter on atmospheric air and the psychrometric chart—the latter indicative of increasing interest in air conditioning.

For the practicing engineer, the book offers a chance to "brush up" with minimum effort.

A.S.H.V.E. Guide

A.S.H.V.E. GUIDE (1936)—*Published by American Society of Heating & Ventilating Engineers, 51 Madison Ave., New York, N. Y. 1080 pages, 6x9 in. Flexible covers. 270 pages catalog data. Price, $5.*

Fourteenth edition of this reference book and text compiled by more then 200 engineering specialists. Technical data section has 816 pages in 44 chapters containing new data on fundamentals of refrigeration, air conditioning, drying, electric motors, stokers, unit heaters, condensers and coolers. Problems in practice at the end of each chapter. Also contains list of members and other data on society in section at end. Bulkeley psychrometric chart (17x20 in.) pasted in back.

Graphical Math

GRAPHICAL SOLUTIONS (1936)—*By Charles O. Mackey, Asst. Prof. of Heat Power Engineering, Cornell University. Published by John Wiley & Sons, Inc., 440 Fourth Ave., New York, N. Y. 130 pages, 6x9 in. 53 diagrams. Cloth covers. Price, $2.50.*

Here's how to make charts to solve much-used equations, thus speeding and easing solution and lessening chances for errors. Types include stationary adjacent scales, sliding scales, network charts, alignment charts and combinations of these solutions. These are discussed in the first four chapters; the fifth deals with fitting equations to experimental data and method of determining the values of constants in non-periodic equations.

An outgrowth of a college course, this text is planned primarily for college use, but can be used by anyone having a working knowledge of logarithms, algebra and a little plane geometry. Treatment is elementary, mathematics simple.

Milan Electric 50

NEL CINQUANTENARIO DELLA SOCIETÀ EDISON (ON THE 50TH ANNIVERSARY OF THE EDISON SOCIETY)—*By various authors. Published by Società Edison, Milan, Italy. 4 vols., 510, 487, 632, and 318 pages. Free, to a selected list.*

Oldest among public utilities of the Continent, and still one of the largest, Società Edison recently celebrated its Golden Jubilee. Managing Director Giacinto Motta initiated the project of tracing the technical and economic development of the electrical industry to date, each subject being entrusted to a particularly qualified author, with Prof. Giorgio Mortara of Milan University as general editor. The first volume is purely technical in character, the second deals with economic factors and their influence upon power-system development in each of the principal power-producing countries. The third volume continues this study, and the fourth contains two monographs, the first dealing with the growth and economic development of Milan and the second with the history of the company. First and fourth volumes are profusely illustrated, and many of the illustrations, though captioned of course in Italian, will prove of interest to statistically or historically minded power engineers. Copies are available by writing to the Managing Director, Società Edison, Milan, Italy, who is personally supervising its distribution.

BRIEF REVIEWS

A.S.T.M. TENTATIVE STANDARDS (1935). *Published by the American Society for Testing Materials. 260 S. Broad St., Philadelphia, Pa. 1500 pages. Price, cloth binding, $8, paper cover, $7.*—Contains 290 tentative standards, 75 new and 65 revised. Includes standards on seamless steel heat-exchanger and condenser tubes and grindability tests and screen analysis of coal.

SURFACE WATER SUPPLY OF CANADA *(Water Resources Paper No. 67) 1935. Published by the Dominion Water Power and Hydrometric Bureau, Dept. of Interior. Ottawa, Canada. 316 pages, 6½ x 9¾ in. Paper. Almost entirely tabular. Free.*

INDEX TO A.S.T.M. STANDARDS AND TENTATIVE STANDARDS (1936). *Published by American Society for Testing Materials, 260 S. Broad St., Philadelphia, Pa. 160 pages, 6x9 in. Paper. Free.*

ELECTRICAL YEAR BOOK (1936). *Published by Emmot & Co., Ltd., 31 King St., West, Manchester 3, England. More than 325 pages. 4¼x6¾ in. Cloth. Many diagrams, charts and tables. Price, 1 shilling, 6 pence.*—Tables on cables and conduit capacity have been revised to conform with new I.E.E. regulations. Other new subject matter on protective systems for generators and regulation.

REPORT ON OIL-ENGINE POWER COST FOR 1934. *Published by the American Society of Mechanical Engineers, 29 West 39th St., New York, N. Y. 32 pages, 8½x11 in. Paper. 25 pages of tables, 5 charts. Price 75 cents.*—Production costs of oil-engine power plants submitted at annual A.S.M.E. meeting in New York, Dec. 2 to 6, 1935.

A.S.T.M. PROCEEDINGS. 1935 (1936). *Published by American Society of Testing Materails, 260 S. Broad St., Philadelphia, Pa. Part I, 1488 pages, and Part II, 769 pages. Price, $5.50 each, paper cover; $6, cloth; and $7, half leather.*—Part I contains committee reports (and appended papers) and new and revised tentative standards. Part II gives all technical papers and extensive discussion.

PURDUE ENGINEERING RESEARCH BULLETINS. *Listed in Purdue News (Dec., 1935). Published by Engineering Experiment Station, Purdue University, Lafayette, Ind. 8 pages, 6x9 in. Paper. Free.*—Lists publications of the Engineering Experiment Station and Engineering Extension Dept.

ENGINEERING EXAMINERS (1935). *Proceedings of Sixteenth Annual Convention of National Council of State Boards of Engineering Examiners, P. O. Drawer 1404, Columbia, S. C. 136 pages, 6x9 in. Paper. 7 tables. No price.*—Minutes of meeting held Oct. 23-24, 1935, in Columbus, Ohio.

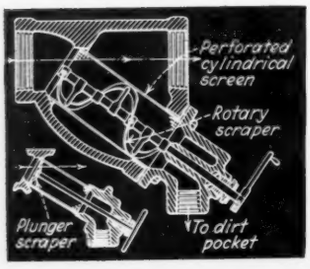
PASEDENA (CALIF.) MUNICIPAL LIGHT & POWER DEPT. (1936). *28th Annual Report by B. F. De Lanty, general manager, Municipal Light & Power Dept. 34 pages, 6x9 in. Paper. Many charts, tables and graphs. Free.*

CLASSIFICATION CHART OF TYPICAL U. S. COALS (Dec. 1935). *By A. C. Fieldner, W. A. Selvig, and W. H. Frederic. Published by U. S. Dept. of Interior, Bureau of Mines, Washington, D. C. 22 mimeographed pages, 8x10½ in. Paper. Almost completely tabular; 3 charts. Free.*

HYDRO-ELECTRIC PROGRESS IN CANADA IN 1935 (1936). *Bulletin No. 1871. Published by Dept. of Interior, Dominion Water Power and Hydrometric Bureau, Ottawa, Canada. 5 mimeographed pages, 8x13 in. Paper. Free.*—Brief description of Canadian hydro-projects in progress during 1935.

PROPERTIES OF INSULATING REFRACTORIES (DEC. 1935). *By S. M. Phelps. Published by American Refractories Institute, Pittsburgh, Pa. 6 pages, 6x9 in. Paper. Illustrated.* No. 61 treating behavior under load at high temperatures.

WHAT'S NEW IN PLANT EQUIPMENT



SELF-CLEANING STRAINERS

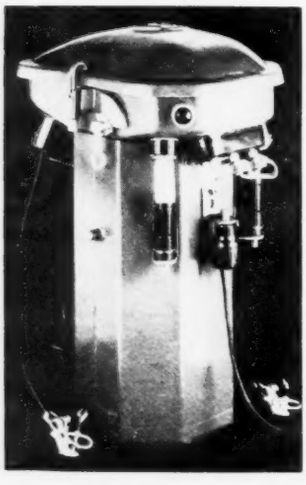
MODIFICATION of pipeline strainer is fitted with plunger or rotary scraper within cylindrical screen, enabling screen to be cleaned without removal. Particularly suited where flow is continuous.

Sarco Co., Inc., 183 Madison Ave., New York, N. Y.

SELF-PROTECTING TRANSFORMER

DISTRIBUTION transformer unit withstands lightning, prevents burnouts from short circuits or overload. Has links in primary winding to protect against feeder outage due to internal winding fault. De-ion gaps furnish lightning protection and internally-mounted thermally-operated circuit breaker in secondary circuit gives visual signal when transformer's temperature approaches burnout zone, and removes transformer when in danger. Type CSP from 1½ to 50 kva., 2,400 to 13,800 volts, 60-cycle.

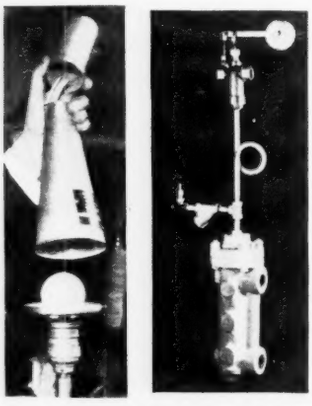
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.



MERCURY VAPOR DETECTOR

MERCURY vapors are detected by selenium sulphide paper strips which turn brown when exposed to vapor, in this detector. Knowing how long selenium-treated paper has been exposed and determining intensity of brown by comparison with chart, concentration of mercury vapor can be determined. Consists of aluminum shade or cone about 4 in. in diameter at bottom, 2 in. in diameter at top and 8 in. high. Holder for strip of selenium paper is in cone fitted to heavy-duty lampholder with socket for 25-watt red bulb. Heat from lamp causes fairly constant flow of warm air up through cone so that apparatus may be calibrated to show concentration of mercury vapor in room. Color scale has six colors uniformly graduated.

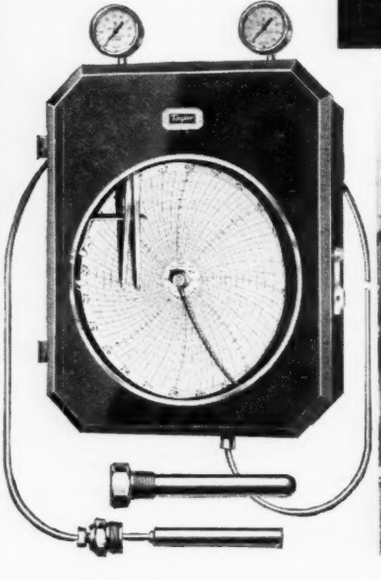
General Electric Co., Schenectady, N. Y.



SEPARABLE THERMOCOUPLE WELL-TUBE SYSTEM

TO OVERCOME time lag in response caused by extra thickness of metal and dead air space between well and bulb in separable thermocouples. "Thermospeed" is claimed to have a speed closely approaching bare-bulb thermocouples.

Taylor Instrument Cos., Rochester, N. Y.



PLASTIC INSULATION

ADA-STIC, plastic insulation for up to 2000 deg. F. can be applied by hand, trowel or Botfield cement-spraying equipment. Said to adhere firmly to any clean surface, and stand up under hard usage. Circular.

Botfield Refractories Co., Swanson and Clymer Sts., Philadelphia, Pa.

MAKE-UP WATER CONTROL

(Cut at left)

FOR use with Morehead systems, this control automatically provides make-up water as the boiler demands. May be installed in connection with any back-to-boiler system.

Morehead Mfg. Co., Detroit, Mich.

AIR ELIMINATOR

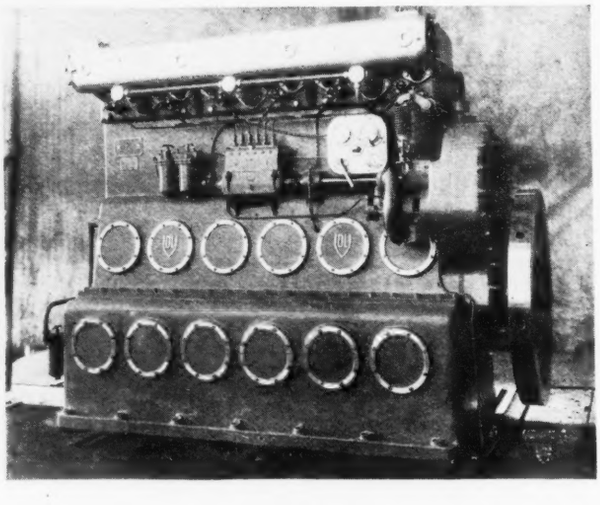
FOR removing entrained air from cold steam systems, this air eliminator for Anderson Super-Silvertop inverted-bucket steam traps utilizes the Spencer Thermostatic Disc. In cold position, disk curves out and away from three large auxiliary ports on side of inverted bucket. Air can then pass through trap. Eliminator remains open until critical temperature is reached, then closes, covering ports. Trap then operates normally.

V. D. Anderson Company, 1935 West 96th St., Cleveland, Ohio.

MEDIUM-SPEED, 4-CYCLE 9x12-IN. DIESEL

MODEL VE solid-injection unit supplements an older line of slow-speed, heavy-duty engines, for oil pipeline, generator, and centrifugal pump drives with or without speed-increasing gears, and where light weight and compactness are important. For stationary service to 720 r.p.m., 4, 6 or 8 cyl., b.hp. from 120 (4 cyl.@400 r.p.m.) to 400 (8 cyl.@720). All working parts accessible and renewable. Total enclosure. Pressure lubrication through drilled passages; no oil piping inside engine. Removable C.I. liners. Up to 600 r.p.m., pistons are C.I., above that aluminum alloy. Cylinder heads cast integral for each two cylinders. Camshaft gear driven. Bosch fuel pumps and spray valves, individual fuel pumps for each cylinder delivering metered quantity through multi-orifice spray valve into pear-shaped combustion chamber. Accessories include fly-ball governor, attached centrifugal water pump and fuel-service pump, lubricating oil pump, fuel-oil strainers, duplex lubricating-oil strainers. Other accessories (not standard) include hydraulic governor, and instrument board carrying tachometer, lube-oil pressure gage, exhaust pyrometer, push-button air-starting control, hand throttle for starting and stopping. Bulletin 87.

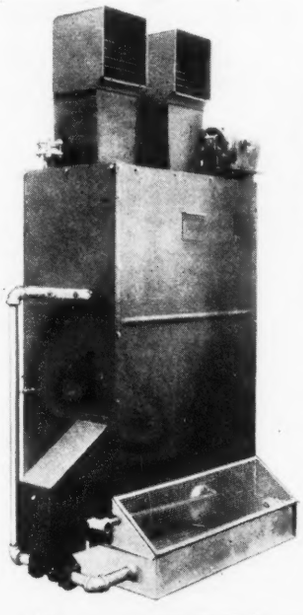
De La Vergne Engine Co., Paschall P. O., Philadelphia, Pa.

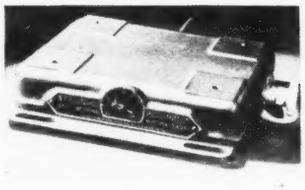


ECONOMIZER FOR AIR-CONDITIONING

To REDUCE water consumption of air-conditioning systems, this economizer is a combination forced-draft cooling-tower and refrigerant condenser for indoor or outdoor installation. Fan passes outside air through pipe coils over which water trickles. Refrigerant condensed inside coils falls to liquid receiver in base. Cooling water recirculated from drain pan by pump driven by ⅛-hp. motor. Make-up water replenished automatically by float valve. Seamless-steel liquid-receiver with dished-head is provided with vortex eliminator to insure minimum liquid level and maintain liquid seal. Standard capacities from 3 to 50 tons of refrigeration, larger sizes assembled in field.

York Ice Machinery Corp., York, Pa.





MOTOR BASE

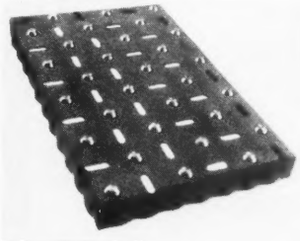
"STRAITLINE" automatic motor base for operating with Vari-Pitch Texrope Sheave maintains uniform belt tension throughout speed range. Dial indicator shows tension of V-belt. 4 totally-enclosed ball-bearings support motor and upper half of motor base. Handwheel on base controls speed of sheave and simultaneously moves motor to compensate for change in centers between shafts.

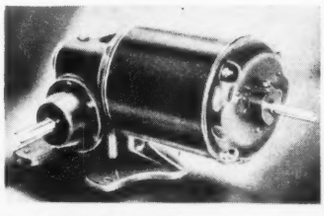
Allis-Chalmers Mfg. Co., Milwaukee, Wis.

STEEL PAVING PLATES

PERMANENT and protective surfacing for concrete floors and paving, anchored on surface of concrete slabs. Two kinds of ⅛-in. rolled steel for roadways and plant floors, have crimped sides perpendicular to surface. Floor type has smooth surface with long-shank anchorage studs, with flat heads, fastening through countersunk holes, making them flush with top surface. Standard size is 12 by 18 in., with 1½-in. sides.

Bethlehem Steel Co., Bethlehem, Pa.





FRACTIONAL HP. GEAR-MOTORS

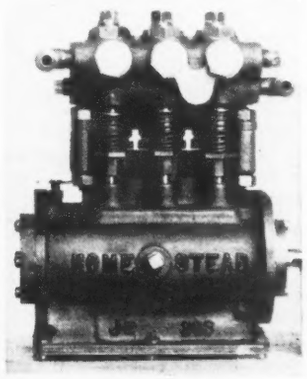
FOR direct connection to stokers, agitators, conveyors, low-speed pumps, etc., these gearmotors are available in single- and double-reduction with right-angle-shaft drive, and single-, double- and triple-reduction for parallel-shaft drive. Speeds as low as 6 r.p.m. Illustration shows single-reduction right-angle drive with outspeed of 30 r.p.m., driven by ⅛-hp., 110/220-volt, 60-cycle, 1,725-r.p.m. motor. Ball-bearing, single-phase, repulsion-start-induction motor with high-speed shaft extension. Gear case incorporates phosphor-bronze worm - gear driven by a heat-treated nickel-alloy-steel worm. Low-speed output shaft supported on two roller bearings.

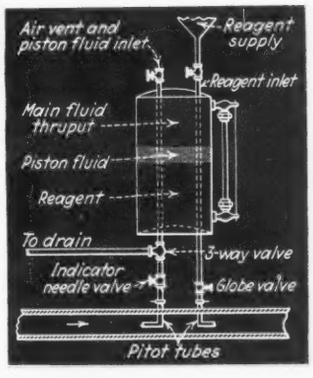
Wagner Electric Co., 6400 Plymouth Ave., St. Louis, Mo.

SMALL-CAPACITY POSITIVE PUMP

MINIATURE triplex-plunger reciprocating pump for small quantities of fluids at relatively high pressure. Capacity variable from about 15 to 120 gal. per hr., depending on speed. ¾-hp. motor for 60-gal. per hr. at 200 lb. pressure. Single-acting plunger type pump has three cylinders ¾-in. by ⅝-in. with plunger attached to crosshead guides driven by connecting rods from crankshaft. Monel metal poppet-type inlet valves positively actuated through cam and tappet mechanism and outlet check valves with adjustable limited lift for high-speed operation. Splash lubrication in semi-steel crank case. Pressure range 0 to 500 lb. Suitable for boiler feed, boiler compound injection, condensate returns, small hydraulic presses, fuel-oil pumps for oil burners, air-conditioning apparatus, etc.

Homestead Valve Mfg. Co., Coraopolis, Pa.





PROPORTIONING SOLUTION FEEDER

MODEL "A" low-priced, proportioning solution feeder uses chemically inert fluid heavier than main fluid and lighter than reagent as piston. Flow pushes reagent into liquid line. Booklet.

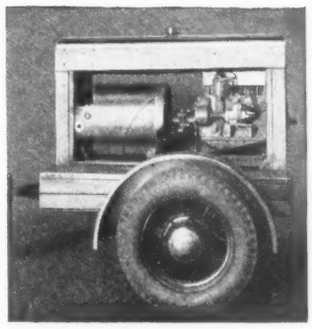
D. W. Haering & Co., Inc., 3408 Monroe St., Chicago, Ill.

PACKING

(Correction to Mid-December, 1935, item)

"STAPAX" semi-metallic, semi-plastic packing in loose form for stuffing boxes and coiled for valve stems and rods. Contains metal alloy for wear, and asbestos, impregnated with solid lubricant, besides other ingredients for elasticity, moldability, and to resist acids. Coil form in sizes from $\frac{3}{16}$ to 1⅛ in. wide.

Rhodes Packing Co., Chatham, N. J.



ARC WELDER

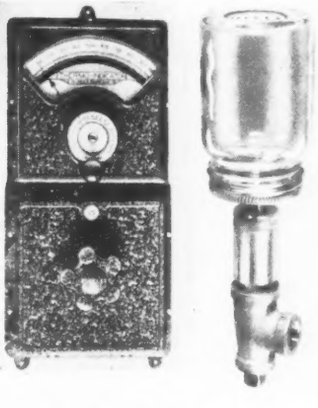
GASOLINE-engine or motor-driven 150-amp. arc welder, Model W-150, for welding jobs using bare or coated electrodes from $\frac{3}{32}$ in. to $\frac{5}{16}$ in. has single current control by shifting brush holders for current settings over entire range. Mounted on 2-wheel highway trailer, small 4-wheel industrial truck or on skids. Motor-driven model, stationary or portable, with V-belt drive. Gasoline-engine driven units direct connected at 2,200 r.p.m., mounted on steel base.

Harnischfeger Corp., Milwaukee, Wis.

DIESEL TEMPERATURE INDICATOR

USING Wheelco system, this Thermo-Indicator, high-resistance indicating pyrometer for diesel engines will show temperature at up to 39 points. Motor or manually operated switch connects to various thermocouples at 10-second intervals. Seven ranges from 0 to 400 to 0 to 3,000 deg.

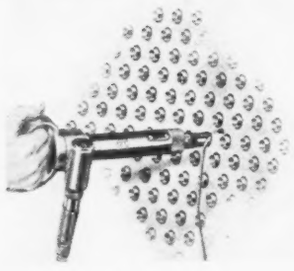
Thermo Control Devices, Inc., Chicago, Ill.



UNIVERSAL OILER

"AU" TYPE "Oilit" has universal adjustable features for application to any type of equipment needing this form of lubrication and allows adjustments of oil level in bearings after installation has been completed. Combines principle of constant level lubrication with visible supply.

National Industrial Products Corp., 1400 West 25th St., Cleveland, Ohio.



ELECTRIC TOOL FOR PACKING CONDENSERS

THIS flexible-shaft tool inserts packing lace in a continuous coil, uniformly and accurately, and tamps it automatically during insertion. Tool sleeve describes a rotary motion about tube, meanwhile tamping three taps per revolution, adjustable in hardness to obtain desired degree of tightness. Sleeve clutch driven from gear train inside aluminum housing. Center guide pin and sleeve interchangeable to suit tube and packing-box sizes. American agent:

Dr. F. Loewenberg, 10 East 40th St., New York, N. Y.

ELECTRONIC SPEED REGULATOR

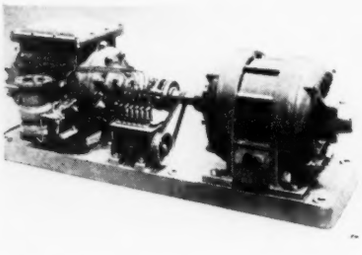
SPEED regulator with one stage of amplification has parallel tubes to avoid change in regulated speed in case of tube failure. Voltmeter on regulator, plugs into tube circuits. Three KU-628 grid-glow tubes excited from 3-phase transformer, supply field current for generator exciter. Current flow through tubes controlled by grid voltage. Grid voltage subject to control by two RJ-571 amplifier tubes in parallel, controlled by voltage difference between pilot generator and 45-volt dry cell.

Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

TWO-STAGE ROTARY AIR COMPRESSOR

"RO-TWIN," sliding-vane, 2-stage, rotary air compressor for pressures up to 100 lb. has both stages and inter-cooler in single casing to reduce length and weight. Has only one stuffing box, one flexible-coupling and two bearings. Available from 20 hp., 1740 r.p.m. to 100 hp., 690 r.p.m. for from 69 to 412 c.f.m. at 100 lb. pressure.

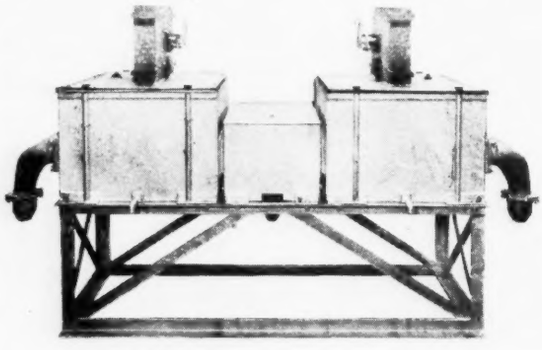
Allis-Chalmers Mfg. Co., Milwaukee, Wis.

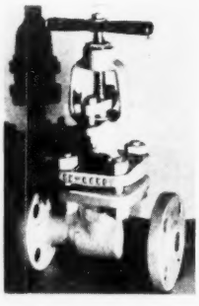


OIL-IMMERSED DISCONNECT SWITCH

OIL-IMMERSED 15-kv. disconnect switch to handle additional feed sources at reasonable cost. Watertight for installation in wet manholes, and suitable for use in steel mills, flour mills, and industries where dirt, dust and explosive hazards are factors.

Delta-Star Electric Co., Chicago, Ill.





FORGED-STEEL GLOBE VALVES

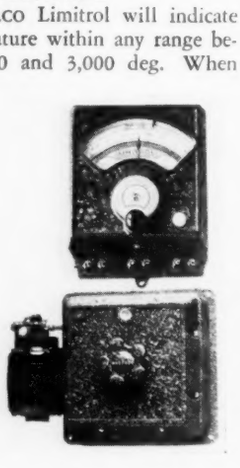
FORGED-STEEL globe valves for pressures up to 1500 lb. with tongue-and-groove bolted bonnet for high-temperature service. Made in cone or plug type with valve seat ring and disc of heat-treated stainless-steel. All parts steel and renewable. Seat ring removable, 20-page bulletin.

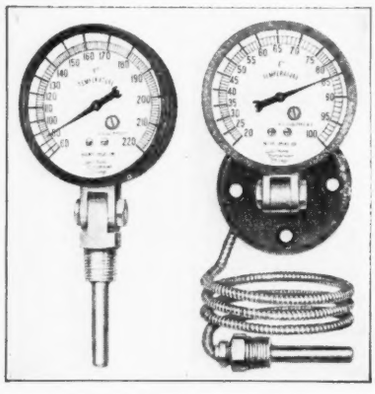
Hancock Valve Co., Bridgeport, Conn.

TEMPERATURE LIMIT CONTROL

WHEELCO Limitrol will indicate temperature within any range between 0 and 3,000 deg. When temperature reaches limit set on index relay operates and rings bell, lights signal, etc. May be used with motor or manually operated switch to connect to up to 39 thermocouples at 10-second intervals. If temperature being tested exceeds limit, device indicates number of thermocouple, stops and shuts off furnace, etc., if desired.

Thermo Control Devices, Inc., 1114 Milwaukee Ave., Chicago.





UNIVERSAL SOCKET DIAL THERMOMETERS

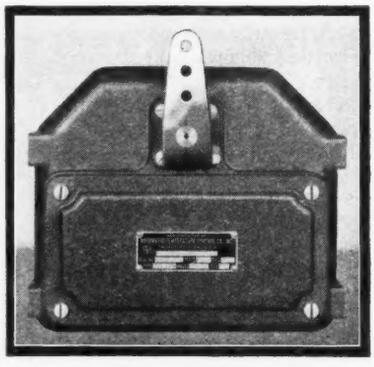
TYPE 61 self-contained universal-socket dial thermometer eliminates specific type of stem for each particular application. Type 62 distant-reading thermometer with 6 ft. of connecting tubing and union or flexible bulb. Thermometer has mounting flange with universal-socket. Ranges from 20-deg. below to 800-deg. above zero available. $3\frac{1}{2}$-in. dial.

Jas. P. Marsh Corp., 2073 Southport Ave., Chicago, Ill.

MOTOR-OPERATED VALVE CONTROLLER

MULTI-POSITION controllers, Relatrol and Balancer produce corrective movement in valve or damper, in accordance with temperature change as measured by actuating instrument. Full-line voltage used in both relay and power motor. Cast-iron housing. Overall dimensions including operating lever are $6\frac{3}{4}$x$9\frac{1}{4}$x9 in. Balancer similar to Relatrol, except provided with automatic means of load compensation for heavily varying loads. Used with many standard pyrometers, flowmeters and other measuring instruments, by slightly modifying contact mechanism. For manual remote control, hand-operated index and dial replaces actuating unit.

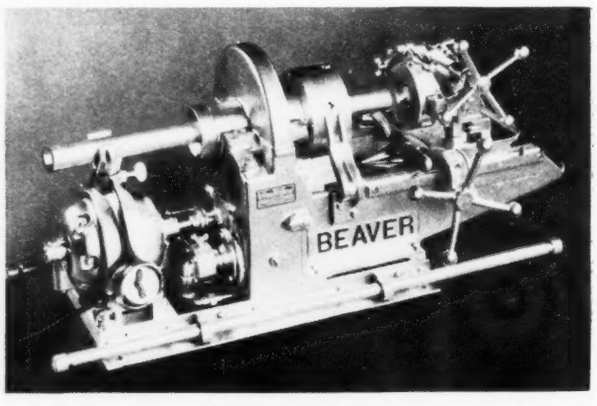
Automatic Temperature Control Co., 34 East Logan St., Philadelphia, Pa.



PIPE MACHINE

MODEL-A Special pipe machine will cut, thread, ream and chamfer $\frac{1}{8}$- to 2-in. pipe, operate geared tools to cut and thread $2\frac{1}{2}$- to 12-in. pipe, cut off solid round bars or stayrods $\frac{1}{4}$ to 1 in., and thread bolts and stayrods from $\frac{1}{4}$ to 2 in. Swinging 8-fluted cone-type reamer. Steel, 3-jaw universal scroll chuck. Inverted rack-and-pinion feed operated by starwheel from front of machine. Reversible, standard-base-mounting, 110 or 220 volt, a.c. or d.c. 25 to 60-cycle motor.

Beaver Pipe Tools, Inc., Warren, Ohio.



Wide World

WILSON DAM IS LEGAL BUT . . .

Recent decision of the Supreme Court makes Wilson Dam (above) legal but leaves undecided questions of Federal competition, "yardsticks," other dams, and purposes and privileges of T.V.A. "Surplus" power was defined but other test cases are inevitable

POWER LINES

12th Street Station Contracts Awarded

VIRGINIA ELECTRIC POWER CO., Richmond, Va., has contracted for following equipment for addition to generating station No. 2, Twelfth St., on which work is now under way: 12,500-kw. high-pressure turbine-generator, with air and oil coolers, General Electric Co.; high-pressure, coal-fired boiler, using powdered fuel, designed for 450,000 lb. steam per hr., with superheater and accessories, and for two air preheaters, and two powdered coal mills, burners, piping, etc., to Combustion Engrg. Co.; coal-handling equipment, Robins Conveying Belt Co.; coal-handling machinery for stocking and reclaiming, Stephens-Adamson Mfg. Co.; transformers and accessories, Allis-Chalmers Mfg. Co.; oil circuit breakers, etc., General Electric Co.; and station motors, Westinghouse Electric & Mfg. Co. Addition will cost about $2,000,000 and is expected to be ready in September. Stone & Webster Engrg. Co., Boston, Mass., consulting engineer.

Other Central Station Orders

NEW YORK EDISON CO. has ordered two 500,000-lb. per hr., 1,500-lb. pressure, boilers from Combustion Engineering Co. for an addition to its Wateside station. Air preheaters, superheaters and economizers have been ordered from Superheater Co. Westinghouse Electric & Mfg. Co. will supply the high-pressure 50,000-kw., 85% power factor, 13,800-volt, 3,600-r.p.m., super-position turbine-generator unit. Turbine will be two-cylinder, non-condensing, impulse reaction with a high-pressure element developing 46,710 kw., at 1200 lb., 900 deg., 200 lb. back pressure. The main unit will be flexibly coupled to a 3,290-kw. feed heating turbine operating at 200 lb. pressure, 502 deg., 5-lb. gage back pressure at the exhaust, bleeding non-automatically at 60 lb. gage at full load. The generator will be largest hydrogen-cooled.

AMERICAN GAS & ELECTRIC CO. has ordered a 1,400-lb., 900-deg., 900,000-lb. per hr. boiler from Combustion Engineering Co., for its Logan, W. Va., plant (for which a G.E. 40,000-kw., 3,600-r.p.m. turbine was ordered).

Chicago Power Conference

EDUCATIONAL phases of the power industry will be emphasized at the Midwest Engineering & Power Exposition and the Power Engineering Conference in Chicago, Ill., April 20 to 24. *Power Economics* will feature the first session, followed by papers on *Power Plant Buildings and Dams, Engines, Refrigeration, Piping and Welding, Fuels, Power Plant Technics, Power Transmission, Fuel Economy* and *Controls* at later sessions. The list of authors includes C. F. Hirshfeld, Detroit Edison Co.; P. E. Stevens, Byllesby Engrg. & Management Corp.; Major T. B. Larkin, U. S. Army; W. E. Zieber, York Machinery Corp.; J. R. Dawson, Union Carbon & Carbide Co.; C. C. Wilcox, John Hahn, Joseph Harrington, N. Rosencrants, Dr. Hall and J. C. Kuhns, Staley Mfg. Co.

Air Conditioning in All-Glass Building

World's first all-glass windowless building, Owens-Illinois Glass Co.'s 20,000-sq.ft., packaging research building at Toledo, Ohio, which has just been completed, contains many innovations in air conditioning. A central station unit is used and an air distributing system exclusive of five private offices is divided into seven zones in which temperature conditions are controlled during both summer and winter, varying the volume of conditioned air admitted in accordance with requirements. A separate supply fan is provided for the five private offices which under winter operation will take a mixture of heated conditioned air at a point ahead of the main supply fan and mix with a quantity of filtered outside air to maintain a duct delivery temperature of 68 to 70 deg. F. Room thermostats are located in each of the private offices and operate steam valves in the steam supply to booster heaters in each branch to provide temperature in each office in accordance with requirements of the occupant. During summer the fan will take cool conditioned air only and room thermostats will control the volume of air admitted through suitable volume dampers.

The equipment has capacity to maintain 83 deg. dry bulb and 50% relative humidity during summer operation when outside conditions do not exceed 95 deg. dry bulb and 78 deg. wet bulb and when the equipment is handling 26,000 CFM comprised of 12,000 CFM fresh air and 14,000 CFM of recirculated air. Under these maximum conditions the equipment requires for cooling 175 GPM of cold water at 53 deg. F. Sensible cooling load on the conditioned space will be 509,000 B.t.u. per hr., comprised of transmission heat gain, sun effect gain and that due to 25¼-motor-hp., 140 occupants and heat liberated by two blueprint machines. In heating the building to 70 deg. when minus 10 deg. outside it is estimated that the B.t.u. loss will be 791,500 B.t.u. per hour. If the equipment is handling 12,000 CFM of fresh air, then the steam requirements of the heating coils and heater for the spray humidifier will be approximately 2,000 lb. per hr. If, however, only 5,000 CFM of outside air is admitted for ventilation to compensate for that exhausted under such periods, then the steam requirements will be only 1,400 lb. per hr.

For winter heating a differential system of control in which air delivery temperature will be varied in accordance with outside temperature existing at any time, will be used. A static pressure regulator in the system varies the volume of conditioned air handled in accordance with aggregate demand of various zones.

Grilles at floor level in the glass block partitions enable the return flow of air to conditioning unit without creating drafts either in the rooms or corridors. Air is cleaned by passing through fibrous-glass filters. Ceilings are lined with fluffy cotton-like fibrous-glass held in place by a decorative screen and acting as sound-deadener.

Smoke Abatement Saves Millions for Hudson County

More than $1,000,000 in cash has been saved by fuel users of Hudson County, N. J., as a direct result of smoke abatement activities according to the annual report of William G. Christy, Smoke Abatement Engineer for the county. "For 1935 the fuel saving was $247,000. The accumulated savings for the first four years of smoke abatement totaled $754,000. Violations on industrial plants have decreased 93% in five years.

A.I.E.E. Nominations

A. M. MacCutcheon, engineering vice-president, Reliance Electric & Engineering Co., Cleveland, Ohio, has been nominated for president of American Institute of Electrical Engineers. Other nominees are: Vice-President, A. C. Stevens, in charge of educational sales, General Electric Co.; O. B. Blackwell, manager of staff departments, Bell Telephone Laboratories, Inc.; C. Francis Harding, head of the School of Electrical Engineering and director of Electrical Engineering Laboratories, Purdue University; L. T. Blaisdell, southwestern district manager, General Electric Co.; C. E. Rogers, chief engineer, Pacific Telephone & Telegraph Co. For directors, K. B. McEachron, research engineer in charge of high-voltage practice, General Electric Co., C. A. Powel, manager, Central Station Engrg. Dept., Westinghouse Electric & Mfg. Co.; R. W. Sorensen, professor of electrical engineering, California Institute of Technology. For national treasurer, W. I. Slichter, professor of electrical engineering, Columbia University.

NEWS NOTES

Bill introduced into U. S. Senate and O.K.'d by its committee on the District of Columbia will provide for inspection, control and regulation of steam boilers and unfired pressure vessels in D. C. Bill would create boiler-inspection service in engineer department for inspection of boilers operating at over 15 lb. per sq.in. or less unless provided with an unassisted gravity return, or any unfired pressure vessel over 60 lb. per sq.in. with capacity over 15 gal.

Air Hygiene Foundation of America, Inc., formed in 1935 for betterment of dust conditions in industry, held its first annual meeting in Pittsburgh, Pa., Feb. 11. The managing director of the Foundation is H. B. Meller, Thackeray Ave. & O'Hara St., Pittsburgh, Pa.

Polytechnic Institute of Brooklyn, N. Y., has established courses leading to degrees of doctor of philosophy in chemical and electrical engineering.

Requirements for repairs by fusion welding on boilers and pressure vessels prepared by the National Board of Boiler and Pressure Vessel Inspectors in cooperation with the Engineers' Conference of the Boiler and Machinery Dept. of National Bureau of Casualty & Surety Underwriters, 1 Park Ave., New York, N. Y., represent a re-issue of a similar set put into effect in May, 1933.

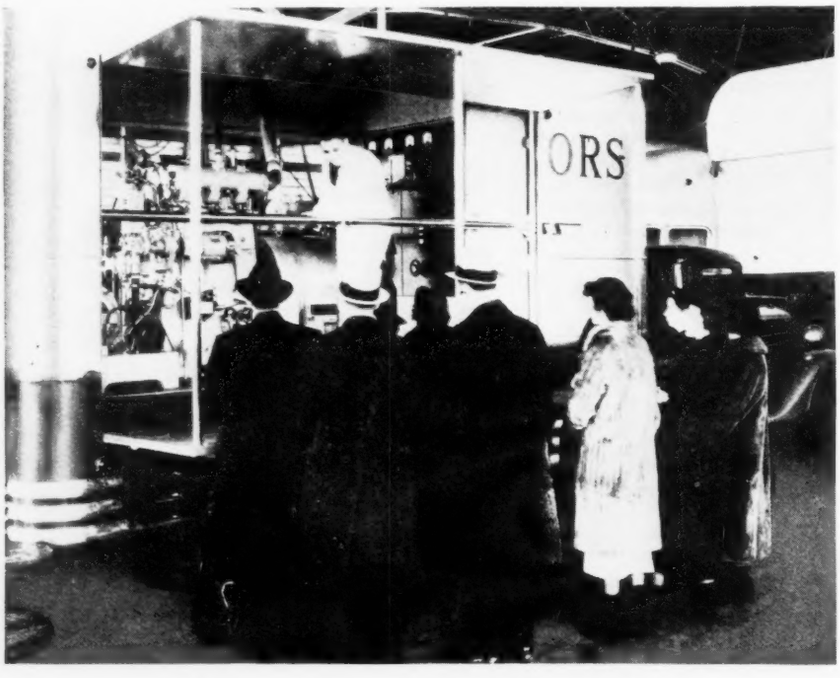
American Chemical Society will hold its Kansas City meeting in the Municipal Auditorium on April 13-17, 1936.

Departments of Mechanical Engineering of the College of Engineering and the University of Wisconsin Extension Division will hold the second conference on solid fuels and domestic stokers in the Mechanical Engineering Bldg., Madison, Wis., April 21, 22 and 23. Prof. L. A. Wilson, Mechanical Engineering Bldg., University of Wisconsin, Madison, Wis., is in charge.

Designing engineers for three Missouri power-plant projects were appointed Feb. 1 by state building commission on recommendation of a bi-partisan advisory board. They are: J. A. Osborn and M. H. Morrison, St. Louis, Mo., associate engineers for State Hospital No. 4, Farmington, Mo., and Arthur K. Mullergren, Kansas City, Mo., state sanatorium, Mount Vernon, Mo., and W. D. Weidlein, Kansas City, Mo., state penitentiary, Jefferson City.

MOBILE POWER PLANT

Powering mechanical exhibits and lighting the big silver-topped tent and 28 streamlined exposition trucks in General Motors' "world's fair on wheels" this 28-ft. Chevrolet tractor-trailer unit carries a 35-kw. Winton diesel direct-connected to a 220-volt A.C. generator



CANADIAN STRAWS

British Columbia pulp mills' agreement for cheap provincial water power rentals for hydroelectric power purposes expire this year and new scales go into force. Rates on water for washing pulp will be reduced, it was announced by the Department of Lands. Rates for hydroelectric water will be approximately tripled to 60 cents per hp. per year.

Preliminary work on Pend Oreille hydroelectric scheme in southeastern British Columbia will proceed this year under the West Kootenay Power & Light Co.

British Columbia Provincial Government has approved application of Vancouver Island Power Co. for permission to divert and use 140 cu.ft. per sec. of water from Loss Creek, 20 miles northwest of Jordan River, on Vancouver Island. Storage of 14,000 acre-feet of water in a reservoir to be created in the natural channel of the creek for power purposes is permitted. Rights are sought as a reserve in case of future power service extensions.

Cardinal Mining and Development Co. has taken over on bond the Aurum property, 15 miles from Hope, B. C., and Bush Consolidated and Bush Cobalt groups, near Premier mine, Portland Canal District, and will install a diesel plant at Aurum capable of running two heavy drifters as soon as weather permits.

City of Winnipeg, Manitoba, will spend approximately half million dollars for construction of third 12,500-hp. unit at civic hydro-plant at Stave Falls. Contract for installation of the generator has been placed with Swedish General Electric Co. for $131,100, while Dominion Engineering Co. will supply turbine and parts for $83,875. Concrete and other work will be carried out by the Hydro's own men.

Electric Panel Mfg., Ltd., 1150 Richard St., Vancouver, B. C., has completed erection of one of largest switchboards ever made in British Columbia. Completely enclosed in steel, board is 9 ft. high and 19 ft. long. Equipment on switchboard includes automatic circuit breakers of no fuse type, compressor panel, two slate panels for generator controls, distribution panel in d.c. section, and throw-over switches. Board has been erected at new plant of Western Bridge Co., Vancouver.

BUSINESS NOTES

Air Reduction Sales Co., Lincoln Bldg., New York, N. Y., and Bausch & Lomb Optical Co., Rochester, N. Y., have become members of Exhibitors Advisory Council, Inc.

Allis-Chalmers Mfg. Co., Cincinnati district sales office, has moved to Chamber of Commerce Bldg., W. G. May continuing in charge as district sales manager.

Crane Co., Chicago, Ill., was host to 200 heating, ventilating and air conditioning engineers, who met in Chicago to attend the Fourth International Heating and Ventilating Exposition, on a tour through their Chicago works. Special guides conducted the visitors through various manufacturing processes from the receiving of raw materials

to the finished product ready for shipment.

CONTRACT WELDERS, INC., 4829 Lexington Ave., Cleveland, Ohio, has acquired Industrial Welding & Cutting Co., 4400 Perkins Ave., Cleveland, Ohio. Two plants will operate as divisions of former until April 1, when equipment and organization will be consolidated as Contract Welders, Inc., at 2545 East 79th St., Cleveland, Ohio.

CROSBY STEAM GAGE & VALVE CO., INC., OF CALIFORNIA, recently organized, will have offices, shops and warehouses at 2034 Santa Fe Ave., Los Angeles, under the management of George H. Christen.

ELECTRICITY DEPT. OF MUNICIPAL COUNCIL OF SYDNEY, New South Wales, is now owned and controlled by Sydney County Council. Contracts in existance with municipal council affecting the electricity dept. will be transferred to the County Council.

FAVILLE-LEVALLEY CORP., 140 S. Dearborn St., Chicago, Ill., have been appointed sales and engineering representatives for Johnston & Jennings Co., Cleveland, Ohio.

HENDRIE & BOLTHOFF MFG. & SUPPLY Co., Denver, Colo., has been appointed representative for Hagan Corp., Pittsburgh, Pa.

LINK-BELT CO. has moved its St. Louis, Mo., district sales office to 1018-21 Louderman Bldg., 317 N. 11th St.

MCCLAVE-BROOKS CO. has moved its offices to Room 585 in the Broad Street Station Bldg., Philadelphia, Pa.

PERSONALS

DR. VANNEVAR BUSH, vice-president, Massachusetts Institute of Technology, and Dean of School of Engineering, will be awarded the 1935 Lamme Medal of American Institute of Electrical Engineers "for his development of methods and devices for application of mathematical analysis to problems of electrical engineering" at the annual summer convention of the Institute in Pasadena, Calif., June 22-26.

RALPH W. BERGEN, 328 Chestnut St., Philadelphia, Pa., has been appointed representative for Illinois Testing Laboratories, Inc., Chicago, Ill., in Maryland, Delaware, Southern New Jersey and Pennsylvania.

A. D. BROWN has been appointed manager of Allis-Chalmers Los Angeles district office to fill vacancy recently caused by death of Boyd Anderson. H. E. WEISS has been appointed manager of Allis-Chalmers Buffalo district office, Mr. Brown's old position.

JAMES CLEARY has been appointed special representative in Power Equipment Division of Foster Wheeler Corp., with headquarters at the New York office of Foster Wheeler Corp., 165 Broadway.

RICHARD J. CULLEN has been elected president of International Paper Co. and International Paper and Power Co. Mr. Cullen became a director of the International Paper and Power Co. on January 10, 1936, and a director of International Paper Co. four days later.

H. K. DUTCHER, electrical engineer of Vancouver, B. C., has assumed charge of construction and operation of Australia's largest hydroelectric project at Tarraleah, Tasmania, which will have a capacity of 105,000 hp. Actual construction work began July, 1934. A year later Mr. Dutcher took charge. Initial power will be switched on by December of this year.

NORBERT D. DOWNEY, for many years advertising manager of Trane Co., La Crosse, Wis., has taken charge of that company's unit heater and gas-fired heater department.

JAMES E. DE LONG, executive vice-president of Waukesha Motor Co., Waukesha, Wis., has been appointed general manager.

R. J. ECKSTEIN has been appointed manager of Cleveland (Ohio) office, 1405 E. Sixth St., of Cutler-Hammer, Inc.

CHARLES J. GASKELL, former plant engineer for Bemis Cotton Mills, and former superintendent of construction with Johns-Manville Co., St. Louis, has been appointed representative for Modine Mfg. Co., Memphis, Tenn.

H. F. HEINEMAN, Wabash Bldg., Pittsburgh, Pa., and EDGAR D. HARDER, 2424 National Bank Bldg., Detroit, Mich., have been appointed sales representatives for Yarnall-Waring Co., Chestnut Hill, Philadelphia, Pa.

WM. LARIMER JONES, JR. and MILTON C. ANGLOCH have been made vice-presidents of Jones & Laughlin Steel Corp., Pittsburgh.

J. E. MARTIN, Chicago manager of the stoker division, Link-Belt Co., was re-elected president of the Midwest Stoker Assn. at the annual meeting held Jan. 27 at the Medinah Club, Chicago, Ill. W. J. O'Neil, sales manager, Chicago branch, Iron Fireman Mfg. Co., was elected vice-president, and H. L. Bilsborough, sales manager, Stoker Division, Fairbanks, Morse & Co., secretary-treasurer.

S. E. LAUER, general sales manager of York Ice Machinery Corp., York, Pa., was elected vice-president in charge of sales at the annual meeting of the board of directors. Offices re-elected at the meeting were William S. Shipley, president; E. A. Kleinschmidt, vice-president and secretary, and S. J. Shipley, vice-president and treasurer.

STANLEY J. MCGIVERAN, manager of sales merchandising of Owens-Illinois Glass Co., has been promoted to assistant general sales manager of all Owens-Illinois divisions.

W. L. REINEKE has been appointed Chicago district manager for aluminum paint division of Aluminum Industries, Inc., Cincinnati, Ohio.

DWIGHT L. MYERS has been promoted to mid-western manager, Mechanical Rubber Goods Division, Thermoid Rubber Co., with headquarters in Chicago. Mr. Myers was formerly assistant manager of Mechanical Rubber Goods Division, working out of Des Moines. This position will be filled by HIRAM A. MYERS, his brother.

EVANS L. SHUFF, 686 Greenwood Ave., Atlanta, Ga., and H. W. THOMPSON, Denver National Bank Bldg., Denver, Colo., have been appointed representatives for Stock Engineering Co., Penton Bldg., Cleveland, Ohio.

ALLAN J. SMITH was recommended for appointment to permanent staff of Vancouver, B. C., for dealing with relations of the city and public utility companies. The recommendation was made to the city council by its utilities committee.

R. H. SONNEBORN has been appointed special sales representative of tubular division, Republic Steel Corp., with headquarters in the Republic Bldg., Cleveland, Ohio.

GEORGE W. STETSON, 141 Milk St., Boston, Mass., has been appointed sales representative for New England for Centrifix Corp., Cleveland, Ohio.

CHARLES R. SURFACE has been appointed sales manager of electric motor sales division of P & H Harnischfeger Corp., Milwaukee, Wis.

OBITUARIES

DR. ELWOOD MEAD, 78, commissioner of reclamation since 1924, ended a distinguished record of public service Jan. 26. A few weeks before his death he was planning a schedule of operations in the great Central Valley project in California. His career reached its fulfillment, however, with the completion of Boulder Dam, of which he had charge of the construction. Dr. Mead was renowned as a teacher and administrator in irrigation, and as a pioneer. Although not a lawyer, he trained and put into operation the irrigation laws of the State of Wyoming, which were later followed by Canada, Australia, South Africa and New Zealand.

JOHN MACDONALD, 77, manager, Northern Ontario Light, Heat & Power Co., New Liskeard, Canada, died Feb. 1.

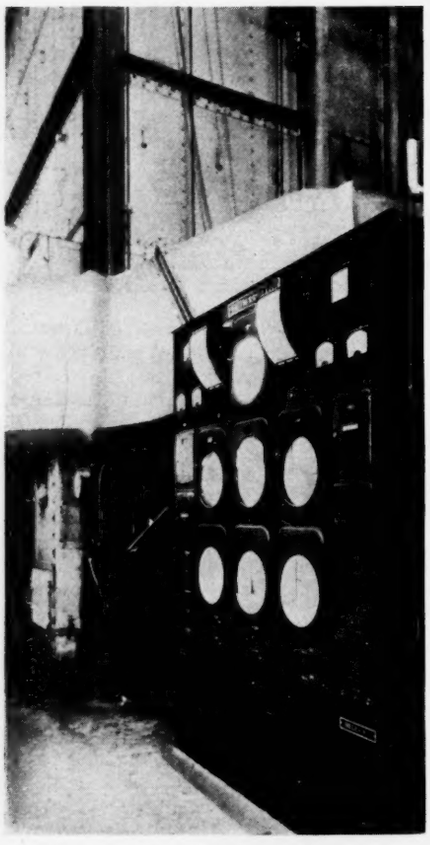
JAMES A. TRANE, 76, vice-president of Trane Co., La Crosse, Wis., died Jan. 24.

FLOYD KING, 59, former state senator and chairman of the board of the Virginia Public Service Co., died Jan. 23.

CHARLES BRYAN COLBERT, 67, city engineer in charge of water and light department at Georgetown, S. C., died Feb. 17.

STRAWS

Pointing the way business winds blow



Control board of the $150,000, 45-ft. boiler in the Ottumwa, Iowa, packing plant of John Morrell & Co. Pulverized Iowa coal from two 120-hp. motor-driven pulverizers is burned in a combustion-chamber 21 ft. wide by 22 ft. deep to produce 450,000,000 lb. of steam per year at 200 lb. pressure.

East

GLENS FALLS, N. Y., plans large electric pumping plant for increased water supply from Halfway Brook to cost about $150,000. Whitman, Requardt & Smith, Charles and West Biddle Streets, Baltimore, Md., consulting engineers.

LAUGHNER OIL & GAS CO., Shippingport, (Beaver County), Pa., plans welded-steel pipelines in parts of Hanover and Potter Townships for natural gas transmission. Application made for permission.

ITHACA, N. Y., is considering plans for municipal plant to cost over $250,000, with distributing lines and facilities. City engineering dept. in charge.

South

WASHINGTON, D. C., has purchased a 750-hp. diesel from Rathbun-Jones Co., subsidiary of Ingersoll-Rand, to be run on sludge gas. Toledo, Ohio, is considering a similar plant.

ROCKY MOUNT, N. C., will receive bids until March 19 for equipment for municipal plant, including 1,050-hp., watertube boiler, with superheater, soot blowers and accessories; 9-retort underfeed stoker, combustion control apparatus and miscellaneous equipment. William C. Olsen, Raleigh, N. C., consulting engineer.

MIAMI, FLA., plans 1-story pre-cooling plant, 45 x 200 ft., in connection with municipal dock and warehouses at foot of Tenth St. $400,000 arranged through Federal aid. Wm. Sydow, director of public service.

TREASURY DEPT., Washington, D. C., plans power plant in new multi-story Federal building on Fifth St., Cincinnati, Ohio, for which bids are to be asked early in April. Cost about $3,100,000. Appropriation has been authorized. Public Works Branch is in charge.

GULF POWER CO., Gant Bldg., 8-10 North Palafox St., Pensacola, Fla., is planning extensive improvements, including air conditioning in its building to which it will move its offices soon.

SEAFORD, DEL., plans new call for bids for municipal power plant, for which bond issue of $130,000 was recently approved. Proposed to begin work in spring.

LEONARD, TEX., has approved $50,000 bonds for municipal power plant and will have plans prepared at once.

LURAY, VA., has engaged Schofield Engrg. Co., Commercial Trust Bldg., Philadelphia, Pa., to make surveys and estimates for municipal power plant. Financing through Federal aid.

TVA HAS awarded Delta Star Electric Co., Chicago, Ill., contracts amounting to $69,600, covering 2,300-volt metal-clad switchgear and 161 kv. switches for Wheeler Dam Development on the Tennessee River.

CRUDE OIL PIPE LINE CO., San Diego, Tex., plans welded-steel pipe-line from oil field near San Diego to Corpus Christi, Tex., where large bulk terminal will be built on waterfront, with power house, pumping station, steel tanks and other facilities. Cost about $600,000.

MIDDLESBORO, KY., has low bid from C. V. Arnett, Berea, Ky., for building for municipal station. Award for distribution system has been given to Monroe Electric Co., Chicago, Ill. R. Husselman, Hippodrome Bldg., Cleveland, Ohio, consulting engineer.

EASTERN TEXAS PETROLEUM CO. has contracted Apex Construction Co. to lindeweld 55 miles of 8-in. pipe from Longview, Texas, to Rodessa, La. Also Phillips Petroleum Co. has awarded contract to White Deere Pipe Lines Co. to lay 40 miles of 2½-to-12-in. pipe at Hobbs, New Mexico, of which 33 miles will be oxyacetylene welded.

SEWAGE AND WATER BOARD, New Orleans, La., asks bids until April 2 for equipment for sewage system in Algiers district, including motor-driven pumping machinery and accessories, underground conduit lines, transformers, switchboards and other electrical apparatus. A. F. Theard, general superintendent.

CROSSETT (ARK.) LUMBER CO., plans large pumping plant for water supply for new local pulp and paper mill to cost $4,000,000 and is scheduled to begin early in spring. Financing arranged through RFC. Hardy S. Ferguson & Co., 200 Fifth Ave., New York, N. Y., consulting engineer.

AUGUSTA, GA., voted $700,000 bond for municipal hydroelectric plant for industrial district, including transmission and distribution lines, substation and service facilities. Burns & McDonnell Engrg. Co., 107 West Linwood Blvd., Kansas City, Mo., consulting engineer.

PONTOTOC, MISS., Board of County Supervisors, plans cold storage and refrigerating plant to cost about $30,000. Financing through Federal aid.

Mid-West

OKLAHOMA MILITARY ACADEMY, Claremore, Okla., plans power house for central steam-heating service, in conjunction with several new buildings. $450,000 arranged for project. Construction contract let to Manhattan Construction Co., First National Bank Bldg., Oklahoma City, Okla. John D. Forsythe, Tulsa, Okla., architect.

GENERAL HOSPITAL, Burnet Ave., Cincinnati, Ohio, plans ice-manufacturing plant to cost about $35,000. Bids will be asked soon.

NEW MARKET, Iowa, has voted bonds for $55,000 for municipal electric plant, and will have plans drawn at once.

DECATUR, IND., has rejected bids recently received for turbine generator unit for municipal plant, and will take new bids soon. Contract has been let to Indiana Engrg. & Construction Co., Central Bldg., Fort Wayne, Ind., for extensions in building. $110,000 arranged for project. Bevington-Williams, Inc., Indiana Pythian Bldg., Indianapolis, Ind., consulting engineer.

HARLEY BARTLES, Shenandoah, Iowa, heads project to construct and operate diesel-electric plant to serve limited area of municipality. Application has been made for franchise. Cost over $80,000.

COLUMBUS, OHIO, is considering $300,000 bond issue for extensions in municipal electric plant, with installation of two boiler units. Robert Tucker, electrical superintendent in charge.

RATHBUN-JONES CO., subsidiary of Ingersoll-Rand, has completed the first of two 1,000-hp. diesels for Southwestern Portland Cement Co.

A. P. GREEN FIRE BRICK CO., Mexico, Mo., has started construction of a high temperature tunnel kiln which will have a continuous furnace section equivalent to 30 individual furances. Elaborate system of control instruments will allow for recovery of all waste heat, which will be used in twin tunnel driers operated in connection with kiln.

UTAH PUBLIC SERVICE COMMISSION, Salt Lake City, has given permission to Utah Power & Light Co. to construct $1,600,000 steam-electric plant near Provo. Plant will have a capacity of 18,850 kw.

GISHOLT MACHINE CO., Madison, Wis., has awarded contracts for a boilerhouse and complete steam-generating equipment, including two 4,600-sq.ft. boilers, 4-drum bent-tube type, Detroit Roto stokers, side-wall water-screens. Internal water treatment is contemplated, with continuous blowdown. Miscellaneous equipment includes Hagan combustion control, Henszey water meter, Cochrane steam flow meters, Hays CO_2 recorders, and draft gages and S. C. feed water regulators. Ash is handled by steam vacuum ejectors from stoker fronts, as well as from soot hoppers under the last pass.

COFFEYVILLE, KAN., soon takes bids for electric-operated pumping plant for sewage treatment works, for which bids will be asked at same time. Cost about $130,000. Charles A. Haskins, Finance Bldg., Kansas City, Mo., consulting engineer.

MO. STATE BUILDING COMMISSION, Jefferson City, plans power plant at state sanitarium at Mount Vernon, Mo. Cost about $200,000, with equipment, for which bids will be asked soon. Baumes-McDevitt Co., Railway Exchange Bldg., and Ralf Toensfeldt, Security Bldg., St. Louis, Mo., consulting engineers; Charles A. Haskins, Finance Bldg., Kansas City, Mo., supervising engineer.

B. A. WELSCHER, Poplar Bluff, Mo., heads project to establish and operate ice-manufacturing plant. Initial unit to cost about $30,000. Company being organized.

KEEWATIN, MINN., plans extensions in municipal power plant. Estimates will be made by Foster & Wahlberg, Medical Arts Bldg., Duluth, Minn., consulting engineers. Special election called to vote bonds.

MILWAUKEE, WIS., has called special election April 7 for municipal power plant. Proposed to purchase plants of Milwaukee Electric Co., and expand facilities. Cost close to $40,000,000.

WAPAKONETA, OHIO, is financing $175,000 for municipal electric plant, and will begin work in spring. Burns & McDonnell Engrg. Co., 107 West Linwood Blvd., Kansas City, Mo., consulting engineer.

CONTINENTAL OIL CO., Ponca City, Okla., plans welded-steel pipe-line for crude oil transmission from oil field at Tepetate, Arcadia Parish, La., to Lake Charles, La., about 44 miles, with capacity of 9,000 bbl. per day. Pumping plants will be built along route for booster service. Bulk terminal for water shipments will be built at Lake Charles, with main pumping station, steel tanks and other facilities. Cost over $450,000. Company is also planning welded-steel pipeline between the two points noted for natural-gas transmission to Mathieson Alkali Co., Lake Charles.

HARLAN, IOWA, contracted Fulton Iron Works, St. Louis, Mo., for one 1,000-hp. diesel-generator and accessories for municipal electric plant to cost about $60,000.

VINITA, OKLA., plans bond issue for municipal diesel plant and distribution system. Special election will be held in spring. Albert C. Moore, Joplin, Mo., consulting engineer.

DOWAGIAC, MICH., plans extensions in municipal electric plant. $200,000 arranged through Federal aid.

PRINCETON, MINN., is considering municipal power plant and will have estimates of cost made soon. Local Commercial Club is active in project.

HOOKER, OKLA., plans extensions in municipal electric plant to cost about $60,000.

SPRINGFIELD, ILL., State Dept. of Public Welfare, Capitol Bldg., A. L. Bowen, director, plans improvements in power house at state penitentiary at Stateville, with installation of two boilers and accessories, stokers, water softener and auxiliary equipment, and improvements in high-pressure steam lines. Improvements will also be made in cold-storage and refrigerating plant. Cost about $95,000. Bids will be asked soon. C. Harrick Hammond, Springfield, state architect.

NORTHERN NATURAL GAS CO., Omaha, Neb., contracted A. O. Smith Corp., Milwaukee, Wis., for 100 miles of 20-in. electrically-welded steel-pipe for natural-gas line from Hugoton, Kan., to Mullinville, Kan., for connection with main transmission line to different points in Nebraska and Minnesota. Compressor stations will be installed for booster service. Will cost over $1,000,000.

HOMINY, OKLA., has low bid from Chicago Pneumatic Tool Co., Chicago, Ill., for three diesel-generator units and auxiliary equipment for proposed municipal plant. Mattison, Wallack & Co., Key Bldg., Oklahoma City, Okla., is low bidder for power house construction. V. V. Long & Co., Colcord Bldg., Oklahoma City, Okla., consulting engineer.

PORTLAND, IND., plans extensions in municipal plant. $179,000 fund arranged. Bevington-Williams, Inc., Indiana Pythian Bldg., Indianapolis, Ind., consulting engineer.

MANITOWOC, WIS., has contracted Wickes Boiler Co., Saginaw, Mich., for boiler unit and accessories for municipal plant, at $29,082; and with Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., for stoker and auxiliary equipment at $25,488.

SWIFT & CO., Union Stock Yards, Chicago, Ill., meat packers, plans rebuilding of gas-generating plant, recently destroyed by fire with loss reported over $500,000.

WINDOM, MINN., has contracted Busch-Sulzer Bros. Diesel Engine Co., St. Louis, Mo., for two 250-kw. diesel-generator units, with accessory equipment, for extensions in municipal plant. $100,000 has been arranged. Rose & Harris, Essex Bldg., Minneapolis, Minn., consulting engineers.

West Coast

YAKIMA, WASH., has authorized surveys and estimates of cost for municipal plant. Financing will be arranged when fund is determined. Henry L. Gray, Henry Bldg., Seattle, Wash., consulting engineer.

EUREKA (CALIF.) ICE & COLD STORAGE CO., plans addition to be equipped as cold-storage and refrigerating unit. Cost close to $45,000, with machinery.

INDEPENDENCE (ORE.) CANNING CO., Earl W. Scribner, head, plans steam power house at new fruit canning plant for processing and other operating service. Will cost close to $60,000.

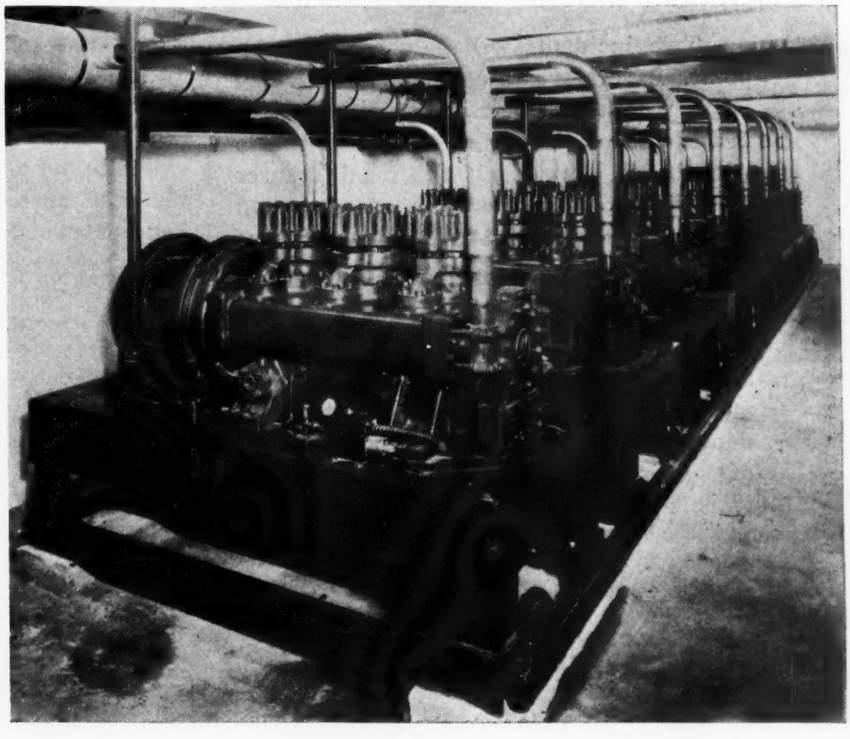
ILLINOIS PIPE LINE CO., Casper, Wyo., will build welded-steel pipe-line for crude-oil transmission from Lance Creek, Wyo., oil field to Fort Bridger, Wyo., connecting with standard Oil Co., of Indiana, Inc. Project includes pumping stations and is to cost close to $400,000. Application has been made for permission.

NATIONAL ICE & COLD STORAGE CO., 85 Second St., San Francisco, Calif., has approved plans for cold storage and refrigerating plant on South Center St., Stockton, Calif. Cost about $60,000.

CLAYTON, CALIF., plans artificial gas plant and pipeline system at Clayton and Concord. Estimates will be made and information secured on equipment. Laurence Olson, Clayton, chairman of committee in charge.

TEAMED AIR CONDITIONING

Hale Bros., Sacramento (Calif.) department store, needs 160 tons of refrigeration for air conditioning. Eight standard Westinghouse condensing units in parallel produce it, with special control preventing starting of two motors simultaneously, and special method of equalizing oil return and maintaining crankcase oil level



BEN'S WHISTLE . . .

Benjamin Franklin once confessed that, as a little boy, he had been so much impressed by a tin whistle a friend was blowing that he offered his whole worldly wealth—a dozen or more pennies—for it. His father laughed him to scorn when he proudly carried it home, for the whistle was worth only a penny. Ever afterward that experience was to remind Franklin not to "pay too much for his whistle."

It is more than easy to be misled on value, to buy on a basis of price rather than of worth. You can bargain as shrewdly as you want to, but the dollar or two you save by too much bargaining will be more than overbalanced by the tens of dollars you lose because of faulty quality. For you're not buying so much cast iron or steel; you're buying experience, reputation and skill, years of pioneering service. You can't expect Damascus steel in a 10-cent knife.

When I buy equipment, I'm primarily interested in what it will do for me. One way is to find out what the same equipment has done for somebody else. Another way is to gage the experience and dependability of the maker, and his ability in repairing and correcting his mistakes.

Two incidents will help to make my point. Several years ago, my friend, Bill Boyd, who has a plant a lot like mine, put in a Blank softener. He'd had some trouble with it, of course, but the manufacturer knew how to overcome the troubles created by Bill's particular water problem, and the softener ran perfectly.

So when I bought a softener, I bought a Blank too, though a good friend of mine sells the Blitz. My Boss was satisfied with my explanation that I knew the Blank was dependable and that its makers had years of experience to correct any possible trouble I might have, a factor which more than counterbalances the few hundred dollars I might save by getting the Blitz.

A couple of years ago, Al Blaney put in a new boiler, which he described as "turning the firing aisle up on end." Of course he had troubles with it—who hasn't with radical new departures? But the point is that the boiler builder and Al between them licked every one. And from the beginning that boiler saved real money; it paid for itself in three years in coal savings.

Some months ago, the chief of a big Southern plant came up to look that new boiler over, and with him came two salesmen of the boiler builder. Asked the Southern chief, "How's she doin'? Had any trouble?" Al replied simply, "Plenty!" They went on from there, Al detailing what troubles he'd had. The faces of the salesmen grew longer and longer. But they didn't notice that as each trouble was detailed, Al also detailed the cure for it—and gave the boiler builder credit. When the trip was over, the Southern chief went home—to write an order for a bigger boiler of the same type. He knew as Al and I do that the company or man that has always made good in the past is the best bet for the next job.

He wasn't going to buy a boiler every day, and first cost didn't mean as much to him as maintenance cost. While he didn't want to pay too much for his whistle, he was willing to pay enough for it to be sure it would blow just as surely and as sweetly next year as it does today.

George Edwards

GEORGE EDWARDS
Engineer